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EDITORIAL.

ITEMS AND NOVELTIES.

The New York and Brooklyn Bridge.—The Bridge Company have not yet concluded the negotiations for a site for the Bridge Tower on the Brooklyn side of the river. This tower will be built in the third or upper slip of the Fulton Ferry. The Ferry Company lease their ferry property from the City of New York, and the Commissioners of the Sinking Fund of this city are vested with the power of leasing and selling public property. When negotiations were opened by the Bridge Company to obtain possession of the upper slip and a section of the adjacent land, the Sinking Fund Commissioners referred the matter to a Commission of Estimate and Assessment, consisting of Wilson G. Hunt and Thos. R. Agnew, who have not yet made their report. It is understood, however, that this will be forthcoming without much further delay, after

which the preparations for the reception of the caisson will be at once proceeded with. Messrs. Webb & Bell, of Greenpoint, have commenced the construction of the caisson, which is to be sunk to the base of the Brooklyn tower of the East River Bridge, and the work is now well under way. Col. William H. Paine is at Messrs. Webb's yard every day superintending the work on behalf of the Bridge Company. It is expected that the caisson will be ready to lauch some time in March. It will then be floated to the location of the Brooklyn foundation. The river shore will be dredged out to low water line, and the caisson floated into its position on a high tide; on the water receding, it will be anchored or "seated," and excavating to sink it the required depth will be carried on in its interior. Through the roof will be six shafts, or funnels, made of ½-inch boiler iron. The two supply shafts through which the workmen descend and ascend, and by which the excavated soil is removed, will be 21 inches in diameter each. Each of the two air-shafts, by which air is supplied to the workmen, is 42 inches in diameter. Each of the two water-shafts, in which the water oozing through the soil will be conducted, so as to keep clear of the workmen, is 7 feet square. On top of this caisson will be piled timber to the height of 15 feet, and the whole mass filled in with concrete, and on this bed of wood and stone will be placed the masonry for the towers. The caisson is in shape a parallelogram, 168 feet long and 102 feet wide on the outside, and is about 15 feet high. The sides are V-shaped, the bottom being 8 inches thick, and the top 8 feet 3 inches, and 10 feet high, and the roof, which rests on three sides, is 5 feet thick. The whole is constructed with yellow pine, a foot square, with the seams caulked. Between the outside layers of timber is a sheathing or layer of tin, between two of felt, intended to prevent the atmosphere from working into the interior of the caisson. The sharp edges of the structure are to facilitate the sinking of the box 30 feet beneath low tide level, and, accordingly, this portion is strongly made. The first layer of timber is of oak; on this is bolted a cast iron shoe, 8 inches wide, oval on its face, being 3 inches thick in the centre. Around the shoe is placed an armor of boiler iron, extending 3 feet above the shoe, on both sides of the wall, the whole strengthened by heavy angle-irons on the interior, 16 feet long. As the pressure of air on the caisson will increase as it sinks, it is estimated that the atmosphere resting on the surface will vary from 18,000 tons to 40,000 tons, consequently, careful

and accurate calculation is made to give strength to the box. The timbers are all bolted together, perpendicularly, horizontally and diagonally, with the heaviest and longest bolts ever used. These bolts are, on an average, 18 inches apart throughout the structure, and the ends are made air-tight by rubber washers. The immense number of bolts may be imagined, when it is expected that 100 tons of them will be used. The interior of the caisson will be a room 166 feet long, 100 feet wide, and 9 feet high. There will be about 1,500,000 lineal feet of timber used in constructing the caisson, and when ready for launching it will weigh 3,000 tons. In order to launch it, there will be seven ways or keels underneath, and a water-tight compartment or air-chamber in the interior, 38 feet wide, extending lengthwise. In addition to this, there are 10 heavy supporting frames to sustain the roof.

New Method of Setting Tires.—A late English patent is for contracting the wheels instead of expanding the tire while the setting is being accomplished: this is done by hydraulic pressure. "As the pressure is applied and the wheel contracts, it is made to descend into a funnel-shaped support, so that when the external pressure is taken off of the rim, the pressure upon the hub, giving dish to the wheel, being still maintained, the contraction of the rim is kept up till the tire is placed around it. The hub being next released from pressure, the elasticity of the wood-work carries the hub back to its normal position. With reference to other parts of the wheel, a general expansion takes place, and the tire becomes permanently set."

A Huge Bridge.—The iron bridge at St. Louis connecting the Illinois and Missouri shores of the Mississippi River, is reported to have been commenced, and 430 men, with all the modern steam appliances for excavating earth and moving heavy stones and timbers are now at work. The bridge structure is to be composed of three wrought and cast iron arches, one of 515 feet in length, the other two 497 feet each. The lower part of the bridge is intended for the passage of railway trains, the upper for ordinary travel.

Steel Fire Boxes for Locomotives.—At a recent meeting of the Master Mechanics' Association, at Pittsburg, Pa., the report of a special committee stated that a locomotive had run on the Northwestern Railroad for eight years with a steel fire-box, which has thus far shown no signs of wear, although the coal and water had proved extremely detrimental to the copper and iron fire-boxes

previously used. Two locomotives on the Pennsylvania Railroad, fitted with steel furnaces in 1861, still remain intact, and about the same time two on the Baltimore and Ohio Railroad were furnished in like manner with the same results. The committee decided emphatically in favor of homogeneous steel plates for locomotive fire-boxes, at least all those that burn bituminous coal; and that for boiler plates for general construction, this material combines in a greater degree than any other requisites of durability, safety and economy.

Annealing Large Cast Projectiles.—The tendency of large casting to burst is well known; the remedy is to provide for homogenity in the casting. The plan suggested for large projectiles is that followed by the Messrs. Whitney & Sons with their car-wheels, namely, to move the cast projectiles from the chills as soon as the metal has "set" nearly or quite to the core; place them in an oven heated to from 700° to 800°, and suffer them to remain, guarded from oxydation by influx of air or gases, until the gradual lowering of the temperature has brought them to the requisite cool condition. The time required for annealing in this manner a 10-inch solid shot is estimated at from 10 to 15 days. The method is worthy of testing by manufacturers who may have occasion to turn out chilled castings of any considerable size.

The "Mahovos."—We take the following from the report of Mr. Auchincloss, on steam engineering, at the Paris Exposition. "A curious invention has recently been produced by Mr. C. Schouberswky, of St. Petersburg. Its object is to dispeuse with steep gradients on railways, by the addition of a carriage to each train, which shall act the part of a store-house for momentum developed during a descent, whence it may be reproduced at will, and assist the locomotive on the opposite ascent. He has given the title of 'Mahovos' to this new motor, and introduced a working model in the Russian Department of the Exposition. The track for the same is 110 feet in length, having a rise of 4 feet in this distance. Near its lowest point is a turn-table for reversing the 'Mahovos,' and a tank to receive the water contained in its train of five cars. The model weighs 275 pounds. The drawings accompanying the report show two ponderous fly-wheels, resting by means of rollers upon a central pair of wheels, which run upon the track between two larger truck-wheels. The five cars filled with water are coupled in front of the 'Mahovos' at the top of the grade. When

ready for starting, the two large fly-wheels are lowered until their axle rests on the four friction-rollers, and these in turn on the six carrying wheels on the truck through the medium of four rolls on their shafts. Under the impulse of gravity, the train commences its slow descent, during which a high velocity is ultimately imparted to the fly-wheels. It reaches the turn-table after a lapse of two minutes. At this point the cars, being detached, continue their journey until the tank is reached, into which, having discharged about 800 pounds of water, they are then led back to the turn-table. In the meantime the fly-wheels, with their shaft, are raised out of gear, the 'Mahovos' turned end-for-end, and made ready to re-ascend after the coupling of the cars takes place. This being accomplished, the fly-wheels are lowered a second time, when the cars rise quickly to the starting point.."

Longitudinal Sleepers for Railroads.—The State Engineer of New York says, in his report on railroads: "There is a growing conviction among engineers that the longitudinal system will become standard. It offers from two to three times as much bearing for the rail as the cross-sleeper system. The whole strength of the longitudinal sleeper is added to the strength of the rail, considered as a beam to carry the load, the strength of the cross-sleeper is wholly wasted. The longitudinal is almost certain to prevent the displacement of a broken rail.

Wagon Tongues.—George Alexander, of Romney, Indiana, has invented a device to retard the jarring of wagon tongues. A piece is bolted to the under side of the tongue, to which is pivoted an iron rod; this rod plays into a cylindrical spring attached to the gearing of the fore axle. The rod is threaded to receive a nut which rests against the spring, and can be regulated to keep the end of the tongue at the height desired, thus preventing, in a measure, the jerking of the breast-chains and the jerking of the collars upon the horse's necks.

The Fog-Whistle at Cape Foucher, N. S.—It is said this whistle may be heard 15 miles in calm weather, 5 to 8 miles in storms, 25 miles with the wind, and 5 to 8 miles against the wind.

Arsenic in Carbonate and Sulphate of Soda.—Fresenius finds that arsenic is often present in carbonate of soda. A sample, being purchased as chemically pure, on being mixed with cyanide of potassium, and heated in a stream of carbonic acid gas, gave distinct traces of an arsenic mirror. Five grammes dissolved in water,

and saturated with hydrochloric acid heated to 70° C., gave clear yellow flocculi with sulphuretted hydrogen. He traces the origin of this arsenic to the sulphuric acid employed in the manufacture, the greater portion of which is now made from arsenical iron pyrites.

Heating Solutions above 212° with Steam at 212°.—In the last number of the English *Chemical News*, which we have received (November 26th), we find an interesting paper by Mr. Peter Spence, F. C. S., in which he describes experiments which led him to the discovery that, if steam at atmospheric pressure and corresponding temperature was passed into solutions of a higher boiling point, it would heat them to temperatures much above that of the entering steam, and, in fact, related to the boiling point of the solutions treated.

Though at the first glance this result seems paradoxical, a little reflection shows us that it is exactly what we should expect from the known conditions.

As every one is aware, steam contains some 1,000° of latent heat—*i. e.*, to turn one pound of water at 212° to steam at 212° will require as much heat as would raise over 1,000 pounds 1°, or, neglecting accidental conditions of the experiment, 1 pound over 1,000°.

Reciprocally, if steam at 212° is converted into water at 212°, this same amount of heat is liberated.

Now, when steam is passed into water, it rapidly heats it by this cause to 212°, but, after that, will no longer be condensed, and hence will impart no higher temperature, but will simply escape with all its heat still in it.

When, however, the steam enters, a dense solution, such as that of sulphate of allumina, mentioned by Mr. Spence, it may be said to combine with it, diluting it by means of the water so added, but yet leaving a solution which will not be vaporized by the higher temperature thus acquired and which thus retains the added heat.

Were it not for the action of the dissolved salt, any rise of temperature above 212°, supposing it to occur from condensation of steam, would cause the formation of a similar amount of vapor, which would reabsorb the emitted heat, and so keep the temperature constant at 212°.

The essential point in this reaction is after all the absorption of the steam by the solution; and while this discovery is of great inte-

rest and value, and a beautiful illustration of the theory of latent heat, we must be careful not to be misled into an inaccurate view of its real significance.

Test for Prussian Blue.—Jerome Nickles found that Prussian blue might be distinguished from the blue of indigo, or aniline, by means of fluoride of potassium, which bleaches it, while it does not so effect the other two.

A New Acid of Sulphur.—Prof. Schutzenberger has discovered an oxide of sulphur, to which he proposes to give the name hydrosulphurous acid, and to its salts hydrosulphites. The formula is SOH, HO. The acid is considerably less stable than its salt, and is produced by the action of sulphurous acid upon zinc.

$$SO_2 + H_2O + Zn = (SO_3)Zn + H^2$$
$$SO_2 + H_2 = SOH, HO.$$

The liquid resulting from the action of the zinc upon a concentrated solution of bisulphide of soda, with exclusion of air, and in a cooling mixture, is poured into concentrated alcohol, and the flask sealed; immediately double crystals of sulphite of soda and zinc deposit on the side of the vessel. The alcohol is decanted and again sealed up and left to itself, when acicular crystals rapidly form. These crystals rapidly effloresce, and must be kept hermetically sealed. Their solution decolorizes indigo, litmus, and precipitates hydrate of copper from its sulphate, and silver from its nitrate. Hydrogen separates in a nascent state. The formula for the soda salt of the new acid is $\left.\begin{matrix}SOH\\Na\end{matrix}\right\}O$, and the free acid would be SOH, HO. As the new acid possesses bleaching properties equal to ozone, further information in reference to it will be looked forward to with interest.

Photographic Exposure Shortened.—In a late number of the *Photographic News*, London, which is, undoubtedly, the best foreign publication of its kind, we notice an interesting paper on the above subject by Mr. William Blair, and an excellent editorial notice of the same.

From these we gather that an increase in rapidity of working in the camera may be obtained by exposing the negative-plates to a little diffused light before or after exposure. The *rationale* of this treatment is, that a certain amount of motion or other change (rendering the film fit to react with the developer) is given to the entire surface, leaving but little more to be done by the localized

lights of the picture in order to cause a deposit to take place with the developer, while, at the same time, this general action is not sufficiently decided to produce any effect without this added action of light, thus leaving the dark portions unaffected, although they are thus brought to the very verge of reaction.

Protective Coating for Small Metal Articles.—Capt. Ross, of the English artillery, has obtained letters-patent for a composition which, applied to the clean surface of iron and other metals, chemically combines with it to form, in the case of iron, a coating of iron itself, but changed in character, so that it will not rust or oxydize, even if steeped in water for a week. Experiments were made on some delicate steel articles, by putting them in the rain and keeping them out on wet grass all night, which ordeal they sustained without gaining a speck of rust. It is hard to say what trade will not profit by this discovery. The composition can be applied to the finest needles and small clock-wheels. It is said to improve the temper of knife or sword-blades.

Working of Plaster of Paris.—When 2 to 4 per cent. of finely-pulverized althea root (*marsh mallow*) is mixed with plaster of paris, it retards the hardening, which begins only after an hour's time. When dry, it may be filed, cut or turned, and thus become of use in making domino-stones, dies, brooches, snuff-boxes, &c. 8 per cent. retards the hardening for a longer time, but increases the tenacity of the mass. The latter may be rolled out on window-glass into thin sheets, which never crack in drying, may be easily detached from the glass, and take on a polish readily by rubbing them. This material, if incorporated with mineral or other paints, and properly kneaded, gives very fine imitations of marble, and can be colored when dry, and can be made water-proof by polishing and varnishing. The chemist and chemical manufacturer will find it an excellent luting for vessels of every kind.

The Albertype.—The London *Photographic News* thus describes the process: "A plate of glass is covered with a solution of albumen, gelatine and bichromate of potash, dried, and exposed to light until hardened. It is then again covered with a solution of gelatine and bichromate of potash, and, when dry, exposed under the negative, and the film is then found to possess qualities analogous to a drawing made with fatty ink upon lithograph-stone. All those portions of the film that were acted upon by the light will refuse water and take printing-ink, while those portions which were pro-

tected from light by the negative will take water and refuse ink. The ink and water will be absorbed by the film just in accordance with the gradations of light and shade in the negative. To produce a picture, wet the surface of the film, then apply ink, lay on paper, and pass through a press: the operation being substantially the same as lithography. The process is said to be rapid, and excellent pictures, of all sizes, may be printed in admirable style."

California Silk.—We have received from Mr. William J. Horstman a beautiful specimen of raw silk raised in California by Mr. D. Prevost, of San José, and reeled on a machine invented by Mr. Joseph Neuman, of the same place.

This material is of an excellent character and in perfect condition, forming a solid hank of the beautiful golden color peculiar to the best raw silk. We learn that much is being done in California by the gentleman on whose estate this sample was produced, as well as by others, and it will evidently be of great advantage, if an industry which represents, yearly, a sum of $214,900,000 can receive such encouragement that it may be fairly established in our country, where so large a demand for its products does and always must exist.

In France, this industry has grown, under governmental protection, from a yearly aggegate of $5,000,000, in 1812, to $140,000,000 in 1860.

Removing Gum from Silk.—A French patent makes known the fact that the removal of gum from silk may be more easily and cheaply obtained by the use of ammonia than by the usual method of boiling with soap.

Percentage of Water in Alcohol.—A simple test of percentage of water in alcohol is to pour a little chloroform into a graduated glass tube, and a given volume of the spirit to be tested is added, and both well shaken up together. On settling, all the water will be found to have separated from the alcohol (which has combined with the chloroform), and may be read off on the graduated tube.—*Artizan.*

Explosive Power of Dynamite.—Experiments with dynamite, under the direction of M. von Arx, gave proof of its extraordinary explosive power. Two and a half cartridges detached a mass of 6½ cubic meters of hard rock in a bore-hole of 1·11 meters depth and 3 centimeters diameter; and three and a half cartridges in a hole 1·32 meters depth, loosened a mass of seventy-one cubic meters.

New Mode of Sharpening Files.—M. Wedermann's plan is to clean the files as usual, and then place them in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid, 80 parts of nitric acid, 1,000 parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises toward the surface; 10 minutes is generally sufficient, when they are taken out and washed, and then the operation is repeated, if necessary.

Separation of Animal from Vegetable Fibre.—Mr. James Stuart, of 40 Ropemakers' Fields, Limehouse, has invented a new process for separating animal from vegetable fibre. He subjects the rags, carpet-cuttings, old carpets, and other waste material of mixed fibres, to a solution consisting of 100 gallons of hot water, 100 pounds of commercial sulphate of alumina, and 50 pounds of chloride of sodium. In this solution the material is kept boiling until the vegetable fibre is decomposed or rotted; the material is then well washed and dried, and scribbled or carded.

Electro-Plating with Iron.—C. M. Clay & Co., of New York City, have patented a galvano-plastic process for electrotyping and plating with iron from a bath composed of the sulphate of iron combined with the sulphate of ammonia, potash or soda.

New Use for Glycerine.—Herr Kolb proposes to add from 1 to 3 per cent. of glycerine to wine to reduce to the smallest possible limits the tendency to change, which all wines, from their inner nature, possess.

Quick-Drying Varnish.—Twelve parts of shellac and four parts of borax, added to one hundred parts of water, carefully heated while the mixture is continually stirred, soon completes a solution which is colorless, or brown, according to the color of the shellac employed. This solution forms a varnish perfectly impermeable to water, and not acted upon by the atmosphere. It can be used with oil-paints, to make them dry quickly, by adding an equal part of the varnish, with a little turpentine, to the oil-colors, and rubbing them together until a homogenous fluid mixture is obtained, This mixture dries in from ten to fifteen minutes, and hence a small quantity must be prepared at a time.

Ornamental Glass may be produced, by vitrifying variously-colored glass in powder on the surface of articles of glass or glazed ware, the fragments being attached preliminarily by some gummy or other adhesive liquid.

Chlorate of Potassa as a Blow-Pipe Test.—In the *Neus Jahrbuh fur Pharmacie*, M. Landauer enumerates instances in which chlorate of potassa may be made useful before the blow-pipe. This salt gives up at higher temperatures some of its oxygen to certain metals, and becomes itself colored from the oxides of those metals. From iron and its compounds it receives a flesh color; from lead a brown; from copper a shade of light or dark blue, in some cases even so deep as to be nearly black. Manganese imparts a purple of variable intensity, and nickel (sesquioxide) turns it to black.

Another Explosive.—"The Lithofracteur" is the name of a new explosive material, invented by Mons. Krebs, of Deutz, and recently the subject of experiments on a large scale at Cologne. The ingredients are kept secret. The advantages claimed are greater power than nitro-glycerine, small production of smoke and perfect safety.

Great Telescopes.—M. De la Rue is having a lens constructed of 13 inches in diameter. Prof. Henry Draper has very nearly completed a new silvered glass reflector of 28 inches in diameter, the largest of the kind yet constructed, except one by Fourcault. With this instrument the original negatives of the moon will be taken 6 inches in diameter, with provision for extending them to 9½ inches if desirable.

Prof. Draper expects thus to obtain photographs of larger size than any that have been produced. There is now being erected at Melbourne, Australia, a powerful reflecting telescope 4 feet in diameter, of Cassegrain form, which will be supplied with the necessary apparatus for photography as well as for spectroscopic investigation.

Another Asteroid.—On the night of the 9th ult., Dr. C. H. F. Peters, the astronomer, of Litchfield Observatory, Hamilton College, discovered a new planet, the ninth to his credit.

Dr. P. writes thus, the next day, to the *Utica Herald:* "A new planet was discovered here last night about midnight. It belongs to the asteroids, and will bear the number 109 of that group. From repeated measurements the position resulted, for half-past one o'clock fourteen degrees and one minute in right ascension, and nine degrees thirty-seven minutes in north declination, with a rapid motion almost parallel to the equator. Its brightness is equal to that of a star of the tenth magnitude, and it has just past its opposition with the sun."

Lead Pipes with a Tin Lining.—A new way of manufacturing lead pipes, with a lining of tin, has been devised by M. J. Grand, Jr. The object is to run the lead in the mould first, and allow the tin to follow while the former metal is still liquid. A rapid movement of rotation keeps the two metals from mixing while a perfect junction is formed as they solidify.

Note on the Supposed Polarization of the Corona.—By Prof. E. C. Pickering.—An observation on this subject is given in my report on page 285 of the current volume of this *Journal*, but as the form of the instrument used has been in one or two cases misunderstood, I enclose a sketch of it. A B (Fig. 1) is a sheet-iron tube, closed at A with a plate of quartz and at B with a prism of Rochon. The latter has the property of giving two images of any object seen through it, separated by an angle of nearly 3°. Looking through the tube we therefore see two images of the quartz touching, but not overlapping. When the light is polarized these images assume complementary tints, which vary with the plane of polarization and the thickness of the quartz. On turning this instrument towards the sun during totality, the images presented the appearance shown in Fig. 2.

Fig. 1.

The hexagons represent in form and size the plate of quartz; the black circles the moon, here drawn a sixth of an inch in diameter, as the scale is about 3° to the inch. The corona appeared white, but the sky surrounding it was colored in one image blue, in the other, yellow,—represented in the figure by vertical and horizontal lines. The conclusion to be drawn from this is, that the light of the corona is unpolarized, or, more strictly, that the amount of polarized light, if any, is too slight to be perceptible with this instrument. Its delicacy, although not equal to Savart's polariscope, is very great, giving colored images with paper, wood and other bodies which reflect a small amount of light specularly. The day before the eclipse it showed, in a very marked manner, the polarization of the wet pavements and roofs. To measure its

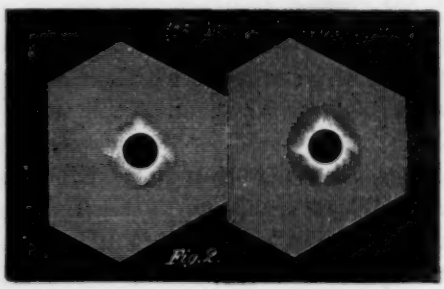


Fig. 2.

sensitiveness, I viewed the light reflected by a piece of plate glass, at different angles of incidence, and found that the color ceased to be visible when this angle was about 10°, which, allowing for the reflection from the second face would give about one part of polarized to twenty-four of natural light.

Observers heretofore have generally attached their polariscope to a telescope, and thus introduced a source of error, avoided in my instrument. For, light passing through the object-glass and field lens, would be polarized by refraction before reaching the polariscope by the obliquity of the incidence, caused both by the curvature of the surfaces and the fact that the edge of the field of view receives its light not parallel to the axis. The plane of polarization would be perpendicular to a plane falling through the axis of the instrument. Now, if any part of the corona was brought into the centre of the field of view, the adjoining portions would appear polarized in planes parallel to the edge of the field, or passing through the sun's centre. In sweeping around the sun's edge the plane of polarization would continually change, as the corona passed through different parts of the field, and the comparative darkness of the moon's disk and the exterior sky prevent the polarization of the other portions of the field from being visible. The degree of polarization by refraction would be very slight and perhaps imperceptible, but the agreement of observation with this hypothesis is certainly a curious coincidence.

The strongest argument against the polarization of the corona is furnished by the spectroscope, the presence of bright lines and absence of dark ones, as observed by Prof. Young, denoting incandescence, a view strengthened by the consideration that each square centimetre of the surface of the corona would receive several thousand units of heat per minute. I am well aware that my results are at variance with those obtained by previous observers, including some of the most eminent astronomers of the day, but as far as I can learn this form of polariscope has not been used for the purpose, and therefore hope that my experiment may be repeated during the next eclipse.

Cause of Bright Line on Partial-Phase Eclipse Pictures. By Prof. Henry Morton.—During the progress of the Eclipse of August 7th, I observed on the negatives, taken during the partial phase by the section of my party with which I had located myself, a decided increase in the opacity of the silver deposit in immediate contact with the advancing edge of the moon. When, after our

return to Philadelphia, all the negatives taken by the other two sections were handed over to me, I found the same characteristic appearance, varying only slightly in degree, to distinguish all of them, and this had, of course, been noticed by those engaged in making the pictures. In fact many remarks have been made upon this point, and some deductions drawn from it.

On the paper prints prepared from these negatives, this local density produced a line of light in contact with the moon's limb.

An appearance similar to this, had been observed by Prof. Alexander, in the photographs taken during the eclipse of 1860, as also by Mr. De la Rue, and while ascribed by Prof. Challis and Prof. Alexander to a very rare lunar atmosphere, had been explained by Mr. De la Rue and the Astronomer Royal, as a subjective effect.

The Astronomer Royal had, moreover, shown, in papers published in the *Monthly Notices* of the Royal Astronomical Society, 1863, Nov. 13, and 1864, June 10, that no such effect would be produced by a lunar atmosphere, were it present. He, therefore, very justly discards such a supposition, and by satisfactory experiments shows that the light line in *the prints under his examination* is an optical illusion and not an existing fact.

These experiments, however, when applied to good prints of our pictures, did not show the same result, and, beside, the actual opacity of the negatives seemed to preclude the above explanation as one accounting for the *entire* effect.

I therefore made the following experiment:—I converted one of the solar pictures, taken soon after first contact, into a crescent, by pasting partly over it a dark circular piece cut from another print. This showed a faint line of light such as results from contrast, and which was no doubt found in the pictures examined by the Astronomer Royal.

I then had this artificial eclipse-picture photographed, (through the kindness of Mr. James Cremer) when negatives were produced showing a dense deposit along the lunar edge, and giving prints which showed a bright line in the same place far more decided than that seen in the artificial original.

It thus appears that the effect observed in these eclipse pictures, while not due to any lunar inflection of sunlight, is also not due to an optical effect of contrast solely, but is in great part due to a chemical action which may be explained by what we know of the chemical reactions concerned in the production of a negative.

It is well known that the development of a negative depends upon the presence of free nitrate of silver in the film, and that a great strengthening or intensifying may be produced by re-immersion in the silver bath, and a second application of the developer. Now, in the present case, part of the plate representing the dark edge of the moon, and therefore not acted upon, furnishes a reservoir of nitrate of silver, imbibed by the collodion film, which, during the development, penetrates for a short distance into the portion representing the *luminous* area of the sun whose supply of free nitrate was exhausted by the reaction which occurred at the first moment when the developer was applied.

My conclusion, then, is, that while a certain effect in the paper prints is, and was on former occasions, due to "contrast," yet in the present instance the peculiar appearance of the negatives, and most of that seen on the prints, is the result of a chemical action such as I have described, and does not represent any celestial phenomenon. The *appearance* of a bright line in the same place which has been noted by several observers is, we believe, due simply to the contrast of the sharply defined lunar edge, which produces the faint line above mentioned, in the artificial eclipse-picture before described.

Editorial Correspondence.

TELLURIUM ORES IN THE UNITED STATES.

Cabinet of Practical Geology and Mining,
General Land Office, Washington, D. C., Nov. 5th, 1869.

Prof. Henry Morton, Ph. D.

Sir:—I take the liberty to send the following for publication in the *Journal of the Franklin Institute.*

All the tellurium minerals formerly known in mineralogy, with the exception of the sylvanite or graphic tellurium, have been found in Calaveras and Toulumne counties of California, together with several new species—the calaverite, a tetratelluride of gold, and the melonite, a sesquitelluride of nickel. Amongst some fragments from Highland, Montana Territory, sent to this office, Dr. Genth discovered a new mineral, the "Montanite," a tellurate of

bismuth, associated with the pure telluride of bismuth or tetradymite. The second variety of tetradymite, that containing sulphur besides the tellurium, has been recognized by him on a broadly foliated specimen received at this office from "Uncle Sam's Lode," near Helena, Montana. It is associated with the new mineral, "Montanite" quartz, and minute quantities of tourmaline; it contains 5 per cent. of sulphur, corresponding with the formula: $Bi S_3 + 2 Bi Te_3$. The yellowish mineral with waxy lustre (the montanite) is a product of the oxidation of tetradymite, and is a hydrous tellurate of teroxide of bismuth. The ore is very rich in gold, and it is claimed to yield, by assay, $100,000 per ton of 2,000.

The native tellurium is distinguished by its nearly tin-white color and metallic lustre. It contains no silver and no gold. The tellurite of gold and silver found in the Stanislaus mine, Calaveras Co., California, exhibits some singular appearances, differing, at the same time, from the tellurite of silver-gold found in Nagyag and Offenbanya, Transylvania, in its physical and chemical properties. Both the tellurite of silver-gold, and the tellurite of silver, contain some silenium. The tellurium reaction of that mineral on charcoal, and in glass tubes, is less characteristic than of the like mineral from Transylvania; but the reaction in treating the ore in a tube with soda and charcoal-powder is very intense.

The analysis of tellurides of silver-gold from Transylvania, and from the Stanislaus mine, is as follows:—

Stanislaus Mine (Blowpipe Analysis).

Tellurium	35·40
Gold	24·80
Silver	40 60

Specific gravity from 9·0 to 9 4.

Transylvania (Analysis by Klaproth).

Tellurium	60 00
Gold	30·00
Silver	10·00

Specific gravity from 5 7 to 5 8.

The Stanislaus mine has been worked to a limited extent, the shaft being only a little over 200 feet deep. The ore is found in layers of quartz, talcose, slate, and lime-spar, extending, sometimes, to a considerable width, and for many feet in length, and is, generally, very rich.

Yours, very respectfully,

A. R. Roessler.

Civil and Mechanical Engineering.

MORTON'S EJECTOR CONDENSER.

[Report of Experiments with the Ejector-Condenser on engines at Albert Works, Glasgow.]

By W. J. Macquorn Rankine, C. E., LL. D., F. R. S., &c.

In accordance with our promise in the last number, we here reprint Prof. Rankine's first report, to which reference was there made.

(1.) The Ejector-Condenser, invented by Mr. Alexander Morton, was applied to a pair of vertical inverted direct-acting steam engines, which exerted collectively a power averaging about 24 indicated H. P. The nominal power of these engines is collectively 7 H. P., if we apply the ordinary rule for low-pressure engines, or 15 H. P. if we apply the ordinary rule for high-pressure engines. The dimensions of the engines and of the condensing apparatus, and the results of the experiments, are given in detail in the annexed table; but as regards the engines, it may be convenient to state here that their two cylinders were of 18-inch stroke, and about 10¼ inches diameter, that they ran at from 93 to 140 revolutions per minute, and that the steam-pressure gauge indicated from 30 to 40 lbs. on the square inch above the atmospheric pressure, which, at the time, was 14·75 lbs. on the square inch. It may be remarked that the experiments throw light on other questions besides the efficiency of the new Condenser; and, in particular, that the accurate measurement of the quantity of condensation-water, and of its change of temperature, affords the means of calculating the total expenditure of steam, and comparing it with the quantity of steam effectively used in doing work, as indicated by the diagrams.

(2. The circumstances under which the experiments were made were, to a certain extent, unfavorable to the apparatus; for the pipe which supplied the tank from which the cold water was drawn for condensing the steam was of too small diameter; and the engines had, from time to time, to be stopped, in order that the tank might be re-filled. It is desirable that a second series of experiments should be made with a cold-water supply pipe sufficient to fill the tank faster than the condensing apparatus empties it. The rate at which the cold water was expended was ascertained by observing on a vertical scale the rate at which the level of the water sank in the tank when the supply pipe was closed; and in this important measurement my own observations were checked by those of Mr. James Brownlee.

(3.) The principle of the invention may be described as follows: In every injection-condenser the cold water rushes into the vacuum with a velocity of 43 or 44 feet per second, or thereabouts. The

exhaust steam rushes from the cylinders into the condenser with a velocity which is many times greater than that of the water. In the common condenser those rapid motions of the water and of the steam are completely checked, and their energy is wasted in agitating the fluids in the condenser, and ultimately in producing heat; and hence it becomes necessary to use an air-pump in order to extract the water, air, and uncondensed steam from the condenser. The power expended in working a well-proportioned and well-constructed air-pump is known, by experiment, to be equivalent to that which would overcome a back pressure on the steam-piston of from $\frac{1}{2}$ lb. to $\frac{3}{4}$ lb. on each square inch of its area, or on an average about 0·6 lb. on the square inch; and that amount of power is lost through the wasting of the energy with which the jets of water and steam rush into the condenser. In the Ejector-Condenser the motion of those jets meets with no interruption; and its energy is found to be sufficient, without any assistance from pumps, to carry all the water, air, and uncondensed steam, if any, completely out of the condenser and into the hot well, and thus to save the power which would be required to drive an air-pump.

(4.) The principal parts of the condensing apparatus on which my experiments were made may be summarily described as follows: The cold water passes from the tank to a conoidal nozzle; the area of the orifice of that nozzle is about equal to that of the injection sluice of a common condenser suited for the same engine—that is to say, about $\frac{1}{25}$th part of the collective area of pistons. Enveloping the cold water nozzles are a second and a third nozzle of nearly similar figure: these bring the exhaust steam from the two cylinders respectively. The middle nozzle has an orifice a little larger than that of the innermost, or cold water nozzle: the outermost nozzle ends in a throat or contracted vein, a little larger still, beyond which is a gradually widening trumpet-shaped mouth-piece leading to a pipe which ends at the hot well.

The condensation of the steam takes place in this interval between the orifice of the cold water nozzle and the throat of the outermost nozzle.

(5.) The completeness and efficiency of the condensation were tested by vacuum gauges and by indicator diagrams. By both means of testing, the left-hand cylynder, which exhausted into the middle nozzle, showed a rather better vacuum than the right-hand cylinder, which exhausted into the outermost nozzle. The average results of the whole of the experiments were as follows:—

Mean vacuum shown by gauges, in inches of mercury	24·6
Do. do. in lbs. on the square inch	12·0
Mean vacuum in cylinders during return stroke, as shown by the indicator diagrams, lbs. on the square inch	10·7
Which, being subtracted from the atmospheric pressure at the time	14·75
Leaves, as the mean back pressure in the cylinders during the return-stroke, in lbs. on the square inch	4·05

The back pressure, in different experiments, ranged between 3 and 4½ lbs. on the square inch. These results are at least as good as the average results as to vacuum and back pressure obtained by means of the common condenser; and they show the condensation of the steam and expulsion of the water, air and vapor, to be at least as complete and efficient.

(6.) I have estimated the saving of power through the dispensing with an air-pump as being equivalent to the doing away with a resistance of 0·6 lb. per square inch area of steam-pistons, and I find it to be, on an average of the several experiments, just one horse-power: being about 4 per cent. of the mean indicated power of the engines.

I have calculated the energy of the jet of cold water, and I find it to be about ¾ of a horse-power. This forms the greater part of the energy which is wasted in the common condenser, rendering an air-pump necessary.

(7.) The experiments, then, so far as they have gone, lead to the following conclusions:—

First. That the action of the Ejector-Condenser is at least as efficient as that of the common condenser, with its air-pump; and

Secondly. That by the use of the Ejector-Condenser the power required to drive the air-pump is saved.

(8.) I have already mentioned one circumstance in the experiments, which was disadvantageous to the apparatus, viz: the insufficient size of the supply pipe of the cold water tank. Another disadvantageous circumstance was the absence of jacketing and of superheating; for, unless one or other of those means be employed, a considerable quantity of steam condenses in the cylinder when first admitted, and re-evaporates during the return-stroke, thus at once carrying heat from the boiler to the condenser without performing work, and injuring the efficiency of the condenser.*

I have calculated, as the Tables show, the total quantity of steam expended from its effect on the temperature of the condensation water, and it proves to be, on an average, about *two and a-half times* the quantity which performs work in the cylinder, as calculated from the indicator diagrams. When applied to engines that are free from this defect, it may confidently be expected that the new condensing apparatus will give, as regards vacuum and back pressure, results surpassing even the very good performance which has been described.

* On this subject, reference may be made to papers by Mr. Brownlee and myself in the *Transactions of the Institution of Engineers in Scotland*, for 1860–61.

TABLE OF EXPERIMENTS

Made on the 27th day of October, 1868, on a pair of Engines at the Works of Messrs. Neilson Brothers.

CYLINDERS.

Area of each, allowing for piston-rods, about.....80 sq. ins.
Stroke.....1·5 foot.

COLD-WATER NOZZLE.

Diameter.....$\frac{13}{16}'' = 0{\cdot}8125''$
Area.....0·638 sq. in. = 0·00443 sq. ft.

WATER TANK.

Area.....$8' \times 3\frac{1}{2}' = 28$ sq. ft.
Mean depth of surface below level of nozzle.....5·25 feet.

WASTE-WATER NOZZLE.

Diameter of throat.....$\frac{15}{16}'' = 0{\cdot}9375''$
Area of throat.....0·690 sq. in. = 0·00479 sq. in.
Diameter of mouth-piece.....3·0″
Area of mouth-piece.....7·07 sq. ins. = 0·0491 sq. feet.

COLD-WATER SUPPLY.

	Cubic feet.	Pounds.
Mean rate of flow per minute.....	$28' \times 0{\cdot}41 = 11{\cdot}48$	$= 716{\cdot}4$
Mean rate of flow per second.....	$0{\cdot}1913$	$= 11{\cdot}94$
Velocity of cold water through nozzle, feet per second.	$\frac{0{\cdot}1913}{0{\cdot}00443}$	$= 43{\cdot}2$

	Feet.	Lbs. per sq. in.
Head due to that velocity.....	29	$= 12{\cdot}57$
Add mean height to which water is lifted.....	5·25	$= 2{\cdot}275$
Total head.....	34·25	$= 14{\cdot}845$

Temperature.....47° Fahr.
Mean work per minute done in raising and propelling water-jet, exclusive of friction...$716{\cdot}4 \times 34{\cdot}25 = 24537$ ft. lbs.
$= 0{\cdot}744$ I. H. P.

BAROMETER.

30·05 inches mercury = 14·75 lb. on the square inch.

SETS OF EXPERIMENTS.	A	B	C	D	E
	Right Hand Cylinder.		Left Hand Cylinder.		
Nos. of diagrams	1	2·3 4·5	6	7·8	9
Revolutions per minute	130	93	abt. 140	107	108
Steam-gauge above atmosph., lbs. on the square inch	34	from 32 to 38		35	from 40 to 30
Do. do., absolute	48·75	fr. 46·75 to 52·75		49·75	fr. 54·75 to 44·75
Vacuum-gauges bel. atmosph., lbs. on the square inch*	12·03 11·54	12·4 12·1		12·3 11·8	
Do. do., absolute	2·72 3·21	2·35 2·65		2·45 2·95	
Mean back pressure	4·25	3·12	4·50	4·38	4·00
Absolute pressure of release	10·75	10·80	8·75	12·00	10·50
Initial absolute pressure	42·75	38·25	32·75	42·75	42·75
Mean effective pressure	15·25	14·83	9·85	16·78	15·90
Mean absolute pressure	19·50	17·95	14·35	21·16	19·90
Temperature of waste water, (Fahrenheit)	86·5°	80·5°		88·0°	91·0°
Elevation of temp. above cold water	39·5°	33·5°		41·0°	44·0°
Heat carried off by water, British units per minute	28298	23999		29372	31522
Velocity of pistons, ft. per min.	390	279	420	321	324
Load of one piston, lbs.	1220	1186·4	788	1342·4	1272
Indicated work, one cylinder, ft. lbs. per minute	475800	331006	330960	430910	412128
Do. do., two cylinders	951600	662012	661920	861820	824256
Indicated horse power	28	20	20	26	25
Indicated work per min. reduced to equivalent quantity of heat	1233	858	858	1116	1068
Total expenditure of heat, British units per minute	29531	24857		30488	32590
Efficiency of engines	0·042	0·035		0·037	0·033
Volume of steam exhausted, as shown by indicator, in cubic feet per minute	433	310	467	357	360
Volume of 1 lb. in cubic feet	35	35	43	32	36
Weight of steam shown by indicator in lbs. per minute	12·4	8·9	10·9	11·2	10·0
Temperature of steam at end of stroke (Fahrenheit)	197°	197°	187°	202°	196°
Total heat per lb. of that steam from temp. of waste water	1087	1093		1086	1082
Heat of condensation of steam indicated	13479	9728		12163	10820
Heat carried off by waste water (as before)	28298	23999		29372	31522
Actual expenditure of steam in lbs. per minute, as calculated from the heat of waste water	26·0	22·0		27·0	29·1
Proportion in which steam actually condensed exceeds indicated steam	2·10	2·47		2·41	2·91
Work in ft.-lbs. per min. saved by dispensing with the air-pump, estimated as equivalent to 0·6 lb. pressure per sq. inch of steam piston	37440	26784	40320	30816	31104
Do., indicated horse power	1·13	0·81	1·22	0·93	0·94

* First result is for left hand, and second result for right hand engine.

ABSTRACT OF PRINCIPAL MEAN RESULTS.

Mean power saved by dispensing with air-pump, indicated H. P.	1·0
Mean indicated H. P. of engines	23·8
Mean back pressure in cylinders, lbs. on the sq. inch	4 05
Mean vacuum in cylinders, do do	10·7
Mean vacuum shown by gauges, do do	12·0
Do. do do in inches of mercury	24·5
About two-thirds of the indicated power were due to the vacuum in the cylinders.	
Temperature of the cold water	47° F.
Mean temperature of waste water	83½° F.
Mean increase of temperature	36½° F.

The Condenser was about 5 feet above the tank from whence the water was drawn, so that the water had to be lifted to that extent. In calculating the pressure due to the velocity *plus* that of 5 feet of water, the sum was found to be a little greater than the atmospheric pressure of 14·75 lb. upon the inch. This must have been caused by the impulse of the steam aiding the atmospheric pressure in accelerating the jet.

(Signed) W. J. MACQUORN RANKINE.

BELTING FACTS AND FIGURES.

By J. H. Cooper.

(Continued from page 316.)

We take pleasure in presenting the following facts contributed by Alexander Bros., manufacturers of Oak-Tanned Leather Belting, 412 North Third Street, Philadelphia.

"It is conceded by all practical men, that oak-tanned slaughter leather is the best material for belting, and as inferior stock such as *chemical* tanned and hemlock leather, colored in *imitation* of oak, by means of quercitron, sumac, &c., is largely used in the manufacture of belting, purchasers should be cautious, in buying, not to get any but pure oak-tanned leather.

"The strongest part of belt leather is near the flesh side, about one-third the way through from that side. It is, therefore, desirable to run the *grain* side on the pulley, in order that the strongest part of the belt may be subject to the least wear.

"In order to prove the above assertion we split, in our machine, a strip of ordinary belt leather exactly in the middle of its thickness, and then subjected each half to a breaking tension, which gave the following results:—Grain side half broke under a direct strain of 468½ lbs. Flesh side half sustained 740½ lbs.

A part of the grain side half is of the same kind of fibre as that of the flesh side, and as the "grain" extends but about one-fourth the way through a hide, much of the strength of the grain half in this experiment is due to the flesh part adhering to it.

"The flesh side is not liable to crack, as the grain sometimes will do when the belt is old, hence it is better to crimp the grain than to stretch it.

"Another important reason for running belting with the grain side on the pulley, is to get greater driving power, that being the smoothest side, it will hug closer, is less liable to slip, and will drive 30 to 35 per cent. more than if run the other way, and if the pulley is covered with leather, grain side out, there will be still greater friction. Therefore a belt will do more work and wear longer on a leather-covered pulley than on any other.

"Belts should *not* be *soaked* in water before oiling, and penetrating oils should but seldom be used, except occasionally when a belt gets very dry and husky from neglect, it may be moistened a little and then have straits or neats-foot oil applied. Frequent applications of such oils to a new belt renders the leather soft and flabby, thus causing it to stretch and making it liable to run out of line. A composition of tallow and oil, with a little resin or beeswax, is better to use. Whitaker's castor oil dressing is good, and may be applied with a brush or rag while the belt is running."

We select the following from the excellent practical treatise on *Mill Gearing*, by Thomas Box, published by E. & F. N. Spon. London. 1869.

"In the table below, the cases of failure are particularly instructive; column 11 shows that in all the cases failure might have been expected. Thus, No. 1 required a 10½-inch double leather belt, where a 6-inch gutta percha one failed to do the work. In No. 2 a larger pulley was substituted, a 7-inch double leather belt should have been used, and the 6-inch gutta percha one did the work badly. No. 4 failed with a 9-inch single belt to do the work for which a 14 inch single or a 7-inch double belt was required. No. 6 required a 10-inch single or a 5-inch double belt, and failed to do the work with a 6-inch single belt. No. 8 required a 13-inch single or 6½-inch double belt and failed with an 8-inch single belt. It will be observed that in cases Nos. 1 and 11 the difficulty was overcome by using larger pulleys: and in cases No. 4, 6 and 8 by converting the single belt into a double one. Circular saws and some other kinds of machinery require extra strength of belt, as shown by No. 18.

"The rules and tables we have given apply strictly to *leather* belts only; leather is in every way the best material, and is not likely to be permanently superseded by the new materials,—gutta percha, india rubber, &c.

"The table shows that the power of a gutta percha belt $\frac{5}{16}$ or $\frac{3}{8}$ inch thick is from 25 to 50 per cent. greater than that of a single leather one. We found in practice that leather belts bear about 310 lbs. per square inch of section, and we may allow that gutta percha will bear about 400 lbs. From direct experiments the cohesive strength of gutta percha is 15 cwt. or 1682 lbs. per

Driving Power of Pulleys, from Cases in Practice.

No.	Nominal Horse-Power.	Diameter of Pulleys. Driver.	Diameter of Pulleys. Driven.	Distance between Shafts.	Belt contact on smallest Pulley.	Speed of smallest Pulley.	Particulars of Belt. Folds.	Particulars of Belt. Width.	Particulars of Belt. Material.	Calculated width of Belt.	REMARKS.
		Feet.	Ft. Ins.	Feet.							
1	10	5	2 6	8	·446	80	Open.	6	Gutta-percha.	10½ double.	Failed entirely; pulleys made larger, see No. 2.
2	10	7	3 6	8	·424	80	"	6	"	7 "	Badly; required resin, and gave trouble.
3	10	10	2 5	30	·472	165	"	6	"	4½ "	Drove well; circular saw, 3′ 6″ diam.; same engine as No. 1.
4	12	7	7 0	32	·58	36	Crossed.	9	Single leather.	14 single.	Failed; strap altered to double one, see No. 5.
5	12	7	7 0	32	·58	36	"	9	Double "	7 double.	Drove well.
6	6	5	5 0	9¼	·5	40	Open.	6	Single "	10 single.	Failed; strap altered to double one, see No. 7.
7	6	5	5 0	9¼	·5	40	"	6	Double "	5 double.	Drove well.
8	18	12½	3 6	20	·424	152	"	8	Single "	13 single.	Failed; strap altered to double one, see No. 9.
9	18	12½	3 6	20	·424	152	"	8	Double "	6¼ double.	Drove well.
10	18	6¼	1 3	19½	·457	770	"	6½	Gutta-percha, $\frac{5}{16}$ thick.	7⅜ single.	Drove, but not well; same engine as No. 8, &c.
11	3	1¼	2 0	12	·49	90	"	6	Single leather.	9½ "	Failed; pulleys made larger, see No. 12.
12	3	2	3 2	12	·48	90	"	6	" "	6 "	Drove well.
13	20	9	5 0	16	·457	65	"	9	Double "	11 double.	
14	12	10	3 0	16½	·43	113	"	9	" "	5½ "	Drove well; pulleys logged with wood.
15	12	3	4 9	11	·473	100	"	8	" "	7½ "	Drove well.
16	12	10	3 0	14	·42	133	"	6	" "	6 "	" "
17	10	6	4 5	14½	·6	49	Crossed.	7	" "	7¼ "	" "
18	10	4¼	2 2	11½	·6	463	"	4	" "	3½ single.	Drove well; extra strong for 4′ 6″ circ. saw.
19	10	8	5 0	20	4·76	64	Open.	9	Gutta-percha.	5½ double.	Drove well.
20	6	7	3 6	13	·46	106	"	5¾	Do. ¼″ thick.	6½ single.	" "
21	6	9	3 6	11	·416	128	"	5½	Single leather.	5½ "	" "

square inch, as shown by subjoined table, which also gives the extensions by different weights. It will be observed that with weights greater than 3 cwt. per square inch the extensions increase rapidly. showing that the material is overstrained. The table gives the mean result of two experiments.

Strain per square inch in cwts.	Length.	Extension per cwt.	Strain per square inch in cwts.	Length.	Extension per cwt.
1	1·007	·007	9	1·100	·0111
2	1·014	·007	10	1·120	·012
3	1·021	·007	11	1·142	·013
4	1·029	·00725	12	1·182	·0152
5	1·040	·008	13	1·210	·0161
6	1·051	·0085	14	1·265	·0190
7	1·064	·00914	15	1.287	·0192
8	1·075	·00937	No. 15 broke.		

BLACKFRIARS BRIDGE.

We take from *Engineering* the following interesting account of this work, just finished. After describing the history and final decrepitude of the former bridge, the author says:—

"The corporation of the city determined upon removing the old bridge altogether, and replacing it by one which should lack nothing in convenience and magnificence.

"The necessary measures having been taken for sanctioning this step, the corporation invited the submission of competitive designs; and, at first, that prepared by Mr. Thomas Page was selected, after a long discussion upon the design of Mr. Brunlees, which was warmly advocated. Mr. Page's design was for a bridge of three spans, with two piers, and would have been a far nobler work than even his bridge at Westminster. Subsequent to this decision, it was considered advisable to adopt a bridge with five arches, corresponding to the number of openings in the adjoining bridge of the London, Chatham Railway Company. Upon this Mr. Page's design was abandoned in favor of the one by Mr. Cubitt, which was finally accepted, the estimate being £269,000. Three hundred thousand pounds has been raised for this purpose out of the Bridge House Estates, the property left in ancient times for the maintenance of old London bridge, and which had been augmented by land purchased in the reign of Edward VI., in St. George's Fields as well as

by the subsequent additions in the City of London, Southwark and the eastern suburbs of the metropolis.

"On the 11th of August, 1863, the first pile of the temporary bridge was driven, and within eight months the structure was completed. It is a magnificent work of its class, and reflects the highest credit upon its designer, Mr. F. W. Bryant, the contractor's engineer. The bridge was built in two floors or storys, so as to afford the greatest accommodation to carriages and foot-passengers, with the least expenditure of space and material. The structure is 290 feet in length, and the foot-ways are 16 feet above the level of the carriage-road. The lower floor (26 feet) is the same width as the carriage-road of the old bridge; the footways above are each 9 feet wide, or 2 feet greater than the sidewalks of the old bridge. With the exception of the three 70-feet openings for the accommodation of the navigation, which are spanned by wrought-iron girders 6 feet deep; the whole structure is of timber. About 300 piles support the platform, placed 18 feet apart, longitudinally, and 7 feet apart transversely, the whole being braced and strutted, until the bridge represents a perfect forest of timber. In consequence of the high level of the footways, the approaching gradients were necessarily heavy for the upper story traffic, being 1 in 10 on each side of the bridge. The gradients for the carriage-way approximated to that of the new bridge, namely, 1 in 40. For five years this work has admirably performed its duties, and would, of course, continue so to do for a lengthened period. Its annual cost of maintenance has been about £930.

On the 8th of June, 1864, old Blackfriars bridge was closed, the traffic was permanently diverted, and the work of demolition went on immediately and with rapidity, the masonry being first broken on the second arch from the Surrey side. The staging and general plant for this portion of the work had necessarily for the most part to be available afterwards for the re-erection, and its design, therefore, presented unusual difficulties. A row of piling was driven on each side of the old bridge, and about 110 feet apart transversely, a third row being carried midway on the bridge itself, thus reducing the bays to 55 feet. Amply strutted and tied together these piles supported on their upper ends, and at a height of 58 feet above low water, longitudinal timbers which carried rails of 40 pounds to the yard, and upon which the travelers ran to and fro. The gantry thus erected had a breadth about 30 feet greater than the width of the new bridge, so that not only could that structure be constructed within its limits, but ample room was left for the transference of material from the lighters to their ultimate positions. As the work of demolition proceeded the central piles were gradually lengthened from below until they ultimately took their bearing in the river-bed. The steam travelers, which had a clear span of about 55 feet, were supported at the ends by the carriage which ran upon the gantry. They consisted of two wrought iron girders, between

which a shaft ran from end to end, and carried gearing which actuated the wheels of the travelers, being driven by a horizontal engine and vertical boiler. The upper flange of the traveler girders carried rails upon which ran a small carriage fitted with pulleys over which chains were passed from below to a drum worked by the engine before mentioned. Within three months from the commencement of the work, the extensive staging was completed and the bridge well nigh demolished, in which operation the stones were detached one by one, picked up by the travelers, from which they were transferred upon lighters, a secure centering having been fixed beneath each arch before it was touched.

The contract undertaken by Messrs. Thorn & Co., extended from the north abutment of the bridge to 180 feet along Chatham Place, and on the southern side from the face of the abutment to 170 feet along Albion Place.

The following are the dimensions of the clear openings and the width of the piers:—

From face of north abutment	to	No. 1 pier,	155	feet.	
" " No. 1 pier	"	No. 2 "	174	feet	5 inches.
" " No. 2 "	"	No. 3 "	186	"	5 "
" " No. 3 "	"	No. 4 "	174	"	5 "
" " No. 4 face of earth abutment,			155	"	0 "

Width of No. 1 pier	18	feet 2 inches.
" No. 2 "	20	" 6 "
" No. 3 "	20	" 6 "
" No. 4 "	18	" 2 "

The new approaches join the existing road levels at the points of the commencement of the contract. At each end of the bridge on the north side, the road is made in a concave curve, with an average rise of 1 in 43·40. On the south side the approach is likewise on a concave curve, with a rise of 1 in 40. These gradients change about 120 feet from the face of the abutments on both sides, and the road surface, the cornices, and the parapets follow a curve of 68,450·5 feet. At 370 feet on each side of the abutment this curve again changes, and joins in a curve of 3992 feet. To follow this varying curve of the roadway, and to give the central rise of the bridge in accordance with the design, the levels of springing of the arches change with each span to the centre as follows:

At the abutments the springing level is	5	feet	above	T. H. W.
At the 1st pier " " "	6·31	"	"	"
At the 2d " " " "	9·06	"	"	"

The rise and clear headway above high water of the several spans are as follows:

	Rise		Clear Headway.	
	Feet.	Inches.	Feet.	Inches.
1st opening	11	7½	17	3
2d "	13	10½	21	6
3d "	15	11¼	25	0

Each pier was enclosed by a series of dolphins connected by boons, which extended from above the new bridge on the north side and round the cylinders of the London, Chatham and Dover Railway Bridge down the river. A part only of this work was included in the contract of Messrs. Thorn & Co. The dolphins were framed with three and four piles according to their position. Those of three piles were of 13 inches × 13-inch timbers, with crossed bracings 13 inches × 6½ inches, bolted with 1⅛ inch bolts. From top to bottom ¾ inch diameter chains extended, upon which the booms were free to move. The booms were of four squared timbers 2 feet 1 inch on a side, bolted together by 1¼ inch bolts, the heads and nuts of which were countersunk into the timber.

The cofferdams of the abutments consisted of two tiers of sheet piling, of which the timbers were 13 inches square, having a space of 5 feet in width between the inner and outer row. The latter consisted of short piles, the heads of which extended only a short distance above the ground, and were driven down into the clay. The inner rows reached to a little above high water, and were driven to a depth of about 37 feet below Trinity high water mark. The space between these two rows was well packed with puddle, and the inner inclosure contained an area 110 feet long by 50 feet wide. This area was divided longitudinally into seven bays by horizontal struts, which abutted upon a central row of piles, that were driven at equal intervals along the whole length of the cofferdam. There were three rows of these horizontal struts, from front to back of the dam, and three rows at similar levels extended up and down its length. This arrangement of dam applied, however, only to the southern abutment, the northern having been built in a single dam.

At the rear of the dam the earth was sustained by a row of sheet piling, kept in place by the system of strutting. The joints between the main piling of the dam were caulked to a depth of 16 feet below high water, and after the completion of the work the outer row of short piles were drawn and the inner row cut off near the ground.

The method pursued in the construction of the piers presented many features of novelty, and has been generally described already in our columns. Each pier stands upon six independent caissons of wrought iron, four of which are rectangular, and the two inner ones are curved to correspond with the contour of the cutwater, beneath which they are placed. In the middle piers the caissons are of larger size, but the construction is identical throughout. The lower or permanent sections of the cutwater caissons are made with an outer iron skin varying from ⅜ inch at the bottom to ½ inch at the top, two of the sides being curved to the outline of the cutwater with a radius of 24 feet 8 inches, the other or inner side being flat. The skin is stiffened by vertical rolled I-irons 6 inches deep, and placed at intervals of 2 feet. These also serve as a means for joining the outer skin, the plates of which are secured to them. The

whole is strengthened by horizontal curbs, placed 4 feet apart in the upper part of the caisson and 2 feet apart at the bottom. In the cutwater caissons the curb is made of three girders, two curved to the proper form and 18 inches deep, and one straight girder 2 feet deep. The ends of all the girders are mitred so as to unite, and are joined at each angle by one inch bolts, a space being left in each case to admit the introduction of a hard wood packing. In the rectangular caissons, which are 18 feet wide by 36 feet long, the construction is similar; the curbs are, however, only 18 inches deep, and consist, like the others of ordinary plate girders, the top and bottom flanges of which are 9 inches × ½ inch, with angle irons 4 inches × 4 inches by ½ inch, and the web ¼ inch thick; the latter are strengthened by angle iron stiffeners 2¼ inches × 2¼ inches × ¼ inch, placed at intervals. Midway of the greater length of these caissons was placed a lattice stiffening girder, 13 feet 8 inches long and three feet deep. The top and bottom flanges are of angle iron 4 inches × 4 inches by ½ inch, and the lattice bars are also angle irons. As at the junction of the curb-girders a space was left for packing at the ends of this stiffening girder. The curbs were secured in place with wrought iron clips on one side of the flange, and cast iron blocks on the other, or a length of timber was substituted for the latter, which is driven between the flange of the curb and an angle iron above. At the bottom the caissons are stiffened with a plate and angle iron 4 inches × 4 inches × ½ inch, rivetted to the outer skin 8 inches from the lower edge, a second angle iron of the same dimensions being secured to the I beams, which are chamfered off to a sharp edge at the ends. The height of the lowest section of the caissons is 18 feet, that of the upper and temporary lengths was 7 feet. At the union of the different lengths a water-tight joint was secured in the following manner. The top of the lower length, and the bottom of the one superimposed on it, were made with sills of angle iron 4 inches × 4 inches × ½ inch; to these were secured plates with rounded corners, the surfaces of which were truly planed. Two thicknesses of india rubber were then laid upon the planed plate on top of the bottom length, and the corresponding plate of the upper length took a fair bearing upon the rubber. Bolts, ¾ inch in diameter and 12 inches apart, fastened the lengths of the caisson together through the angle irons. Mallet's buckled plates were used in the upper temporary lengths of the caissons instead of the flat plates employed below; these were $\frac{3}{14}$ inch thick, and formed the only important difference in construction to the lower sections. The six caissons forming the foundations of each pier were placed in position with an interval of 3 feet between each, and they were lowered in the following manner: Guiding piles were first driven, and then by aid of the overhead traveler the caisson was lowered into its proper place until its cutting edge rested on the bottom of the river. The ground enclosed within the area was then excavated, and by weighting the

caisson was gradually forced into the ground. As soon as the clay was reached, leakage from the river into the caisson ceased, and the latter being drained by Woodford's centrifugal pumps, the work of excavation was carried on until the ultimate depth was reached, and the caisson, by protracted loading, took its final bearing. It was expected before the commencement of the work that the caisson would have to be sunk to an average depth of about 47 feet below T. H. W.; but in the case of the No. 1 pier—that nearest the Middlesex shore—it was found that ground into which the caisson had to be lowered had been scoured out so deeply by the action of the Fleet that unforeseen difficulties arose, and the depth of the caisson had to be greatly increased, to the considerable delay of the work. In No. 2 pier the permanent portion of the caisson is 23 feet high, and it is filled in to a depth of 15 feet, with concrete in cement, upon which is placed 8 feet of brickwork, also set in cement. In the other piers the permanent portions of the caissons are 18 feet high, the concrete filling 10 feet thick, and the brickwork 8 feet as before. In all cases the upper edge of the caissons which now are incorporated in the bridge is 4 feet below low water, and in the course of construction, when the brickwork within the caisson was carried up to the top surface, small pile and puddle dams were placed across each 3 feet space between the different sections, the ground dredged out to the level of the bottom of the foundation, the void being filled with concrete in cement, an uninterrupted area was obtained, upon which the masonry of the piers was laid, the movable portions of the caissons being removed piecemeal as the work proceeded.

The abutments are founded upon concrete of varying thickness, according to the nature of the ground. On the top of the concrete at the face of the abutment is placed 3 feet of brickwork, above which rise the courses of the granite facing, the front of the abutment being built with a curved batter of radius of 200 feet. At the point of the arch springing the thickness of masonry and brickwork is 12 feet backed with 30 feet of concrete. The brickwork itself is strengthened by counterforts 18 feet deep and 8 feet wide. The granite used in the abutments, and indeed throughout the bridge, is remarkable for the evenness of its color and texture, and the size of its blocks. The greater part was obtained from the De Lank quarries near Bodmin, in Cornwall, and is the same material as the largest blocks in the Southern Thames Embankment. About 150,000 feet were used in the abutments and piers, and principally in blocks of great size, 80 of them varying from 12 to 20 tons in weight, and some 200 of them from 6 to 10 tons. There are eight courses in the abutments to the springing of the arch, two 3 feet 8 inches deep, two 2 feet 5 inches, and the rest 2 feet. The skewbacks are 6 feet in two courses, the stones of which are cramped with double cramps at each joint, and joggle-jointed to the courses above and below them. The main pedestal of the abutment is sur-

rounded with a granite blocking course 2 feet 3 inches thick, and the level of which is 38 feet 6 inches above Trinity High Water. Upon this it was intended to place the elaborate bronze statuary, which formed a conspicuous feature in the original design, but which, from motives of economy, the Corporation think it advisable not to proceed with at present. Beneath the blocking course of a highly carved capital of Portland stone forms a highly ornate feature in the abutment; it is 5 feet 3 inches deep, and rests upon the granite pedestal. Subsidiary capitals of the same character crown the piers, against which the parapet of the bridge on the one side, and the parapet of the retaining wall on the other, are finished. A third capital also of the same nature, and on a level with the top of the spandril filling of the girder forms a terminal to a heavy projection, arising from the skew-backs. Along Chatham Place on the north, and Albion Place on the south, the parapets of the abutments extend and terminate in a pedestal of Portland stone with truncated conical head, which will carry a cluster of ornamental lamps.

On each side of each abutment is a causeway of an average length of 122 feet and 19 feet wide, running down into the river at a steep slope. Each are paved with stone upon a curved foundation of Barrow line concrete, the sides being protected with sheet piling of American elm 10 inches × 5 inches, main piles 10 inches × 10 inches being driven at intervals of 8 feet A horizontal timber is bolted on each side of the causeway to the street piling by $1\frac{1}{8}$ inch bolts and at every 8 feet a through bolt of the same diameter ties the main piles together. At the face of the abutment the street piling turns at right angles to the causeway and finishes against the abutment. The river steps leading from this level to the street are in three flights with intermediate landings.

The piers are 130 feet long over the cutwater and of the widths given above. Like the abutments, they are built of brick, faced with the De Lank granite, and relieving the end of each pier, from the top of the cutwater, spring short, but massive columns of polished red granite from Mull. The shafts of these columns are only about 12 feet in height and 7 feet 6 inches diameter. Each of them is formed only of three stones, and the shafts stand on Portland stone pediments, while richly ornamented capitals of the same material surmount them. Into the carving of the capitals has been introduced a profusion of flowers, birds and weeds corresponding with the ornaments upon the abutments. Above the capitals rises the parapet 3 feet 9 inches high, broken at the piers from the straight line to recesses some 10 feet deep and 13 feet wide, accommodated with granite seats.

The spaces between the piers are spanned by wrought iron ribs, of which there will be nine in each span; the upper part of these ribs consist of straight, and the lower of arched girders, the former meeting the latter at the crown, and the spandrils being occupied

with a cast iron lattice filling. In construction all the ribs are are alike, but the face girders have cast iron mouldings bolted to them. In getting the ribs into position no complete centres were employed, supporting piles being driven at intervals to support each girder as it was got into place, so that when the cross-bracing was introduced, the keys and wedges driven between the piles and the ribs could be struck and the arch cleared with less expense and trouble than if centering had been employed. The flooring of the bridge is made with Mallet's buckle plates fastened to the road bearers with $\frac{3}{8}$ inch bolts; these being asphalted are covered with a formation of broken stones and asphalte, and upon it is placed the granite pitching of the roadway and the landings of the foot-paths. The cast iron parapet, 3 feet 8 inches high, is highly ornamented, and is designed in the Venetian-Gothic style with vertical openings.

The following are the names of the persons principally concerned in the design and construction of the new Blackfriars Bridge: Mr. Henry Carr, of 4 Victoria street, Westminster, Mr. J. Cubitt, 6 Great George street, Mr. Pickett, Clerk of the Works. The contractors are Messrs. Thorn & Co., their engineer, Mr. F. W. Bryant, President of the Society of Engineers; the iron-work was supplied by Messrs. Lloyds, Foster & Co.; the main portion of the granite was obtained from Mr. C. Goodyear, of the De Lank quarries, and the sculptor who executed the whole of the carvings upon the bridge is J. P. Phillips, Esq., of Hans Place, Chelsea.

The Nile to be Explored in Earnest.—Sir Samuel Baker, at the head of 1,700 men, is to seek the sources of the Nile. The baggage, stores and merchandise, to be used in trade with the natives, have been sent on in advance. Engineers, shipwrights, ten steamers and thirty sailing-vessels, will accompany the expedition. Vessels will be built on the spot for the navigation of lake Albert Nyanza. The expedition will rendesvouz at Khartsum, at the confluence of Blue and White Niles, and proceed along the latter as far as it is navigable.

A Portable Brick Machine has been invented by C. A. Winn, in which the clay is tempered by passing steam through it. The bricks are delivered from the molds hot, which facilitates their drying.

Sulphuric Acid is manufactured at the works of C. Tennant & Co., by decomposing a mixture of nitrate of soda and chloride of sodium. The nitrous acid is absorbed by concentrated sulphuric acid, and the chlorine is utilized for the production of chloride of lime.

Mechanics, Physics, and Chemistry.

NEW METHOD FOR THE SEPARATION OF THE PLATINUM METALS.

By Prof. Bunsen.

(Translated from his late contribution to the "Annalen der Chemie und Pharmacie," entitled "Ueber das Rhodium," by W. H. Wahl.

In the metallurgic process of extracting platinum from its ores, there is obtained three products, which are admirably adapted for obtaining those rare metals which constantly accompany this metal. These products are,—

1. The "Ore Residues," which remain behind after the mass of platinum, &c., has been extracted by aqua regia; these are rich in osmium and iridium, hence best adapted to the purpose of extracting these metals.

2. "Osmiridium," obtained by mechanical washing from the first residue and which is best adapted for obtaining ruthenium.

3. The "Mother-Liquid Residues," left behind in the aqua regia solutions after reduction with iron, the platinum having previously been separated (with chloride of potassium?) These are rich in palladium and rhodium, and are the best for obtaining these metals.

The following researches were made with a material of the last sort; for each separation a kilogramme of residue was used.

The residue contains, with the exception of osmium, all the platinum metals, and is particularly interesting on account of its relatively great richness in rhodium.

Claus' mode of separation (the only one previous to this) involves the loss of much valuable material. To separate the rhodium from iridium, Claus used the old method proposed by Wallaston, which depends upon the solubility of the ammonium (or potassium) double salt of sesqui-chloride of rhodium in chloride of ammonium. The fact, however, that the salt K Cl, $Ir Cl_2$, is taken up in considerable quantity by a solution of chloride of ammonium (or chloride of potassium,) saturated with a rhodium double salt, a fact of which I have repeatedly convinced myself, is sufficient to awake the gravest doubts as to whether the metal given out to be rhodium, and to which Berzelius and Claus ascribed the atomic weight = 52, did not contain considerable quantities of iridium. I found it, there-

fore, necessary to leave the beaten track, and to search for a more exact method of separation.

Separation of Platinum and Palladium from the other metals of the group.

The complete separation of rhodium, iridium and ruthenium from platinum and palladium, by digestion with aqua regia, will not succeed with these questionable residues, as considerable quantities of the first named metals are present in the form of hydrated sesqui-oxides, and partly present in a most finely divided state, and in consequence, dissolve with the platinum and palladium; without taking into consideration the fact the residue left behind by this digestion, is only filtered with infinite difficulty.

On the other hand, it is easy to effect the separation of platinum and palladium from the others, almost completely, if the original material is mixed in a Hessian crucible, with from $\frac{1}{2}$ to $\frac{1}{3}$ its weight of chloride of ammonium, heated until the latter is completely volatilized, allowed to glow gently until only the vapors of sesqui-chloride of iron show themselves, and then placed in a porcelain dish, and evaporated to a syrupy-consistency with from two to three times its weight of raw *commercial* nitric acid. By this treatment with chloride of ammonium, the metals present not belonging to the platinum group will have been partially converted to *lower chlorides;* rhodium, iridium and ruthenium will have been rendered insoluble, and the silica present as gangue, converted from a gelatinous mass, to a finely pulverent condition, in which state it will admit of speedy filtering.

The chlorine compounds, produced by the chloride of ammonium, give us, upon digestion with nitric acid, just enough hydrochloric acid to dissolve the platinum to bi-chloride, while the metallic copper and iron present, act in so far reducing upon the palladium (in solution in nitric acid) that it remains in solution not as bi-chloride ($Pd Cl_2$), but as the proto-chloride (Pd Cl), which latter is not precipitated with chloride of potassium. The mass is diluted with water, filtered, and the solution saturated with chloride of potassium, and the greater part of the platinum separated pure as $K Cl, Pt Cl_2$, which is washed out, first with chloride of potassium, and later with absolute alcohol (the last washings must not be added to the solution). This precipitate weighed 62 grammes.

The filtrate is brought into a large flask (which can be made air-

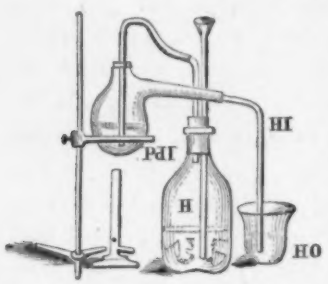
tight), which will not be more than half filled with it. Chlorine gas is led into this flask, and the same is from time to time shaken vigorously, until no further absorption of gas takes place, when all the palladium will have separated as a cinnabar-red precipitate of Kcl, $Pd Cl_2$ (somewhat impure, however, from traces of platinum, iridium and rhodium). This precipitate weighed 157 grammes. The fluid from which these precipitates were obtained, is now evaporated, not quite to dryness, with hydrochloric acid, and upon addition of *just so much water as was necessary* to dissolve out the chloride of potassium and other soluble salts, (aiding the operation by rubbing with a pestle), there remained behind a dirty yellow-colored precipitate. This was separated by filtration, boiled with caustic soda, and a few drops of absolute alcohol, hydrochloric acid was added to dissolve the precipitate formed, and the liquid then saturated with chloride of potassium, the result was a precipitate of 13·5 grammes of chemically pure $K Cl, Pt Cl_2$. The mother-liquid contained only copper, and no platinum metals.

The purification of the cinnabar-red precipitate of palladium was accomplished as follows: It was dissolved in boiling water, whereby a portion of the chloride dissolves (with evolution of chlorine) to Pd Cl. It was then evaporated with 60 grammes of oxalic acid, and dissolved again in a solution of chloride of potassium, whereupon 42 grammes of $K Cl Pt Cl_2$ remained behind, which, upon testing, proved chemically pure. It was washed out as before.

The brown liquid was then somewhat concentrated upon the water-bath, and, upon cooling, there separated 19 grammes of bright green, well formed crystals of K Cl Pd Cl, (with some chloride of potassium) which, upon testing, likewise proved free from the other platinum metals.

The fluid poured off from these crystals was then neutralized carefully with caustic soda, and gave a very slight precipitate of copper and iron, which was filtered off. Upon adding iodide of potassium to the filtrate all the palladium separated as Pd I. To avoid adding an excess of the reagent, it is best to take, from time to time, a drop from the fluid with a capillary tube, and bring the same upon a watch-glass. As long as the precipitation is incomplete, the drop appears, upon a white background, *brown;* when complete, it is *colorless;* when the reagent is present in excess, it is *red.* This weighed 77 grammes, and was tested for its purity by reducing it to metallic palladium and then heating and dissolving in nitric acid;

when pure, it must dissolve completely. The whole mass was now reduced in a slow stream of hydrogen gas (whereby the iodine can be obtained again as hydriodic acid, by absorbing with water); at last the mass must be strongly heated to decompose slight traces of the sub-iodide of palladium (Pd_2I) which are formed.



The mother-liquid from which all this platinum and palladium has been obtained may contain some iridium and rhodium, it is, therefore, evaporated to dryness with a little iodide of potassium, whereby a mixture of the iodides of rhodium and iridium separates; this can either be dissolved in aqua regia, and the two metals separated, as will hereafter be described, by the bi-sulphite of soda, or it can be united with the portion from which these metals will be obtained.

Separation of Ruthenium and of Rhodium and Iridium.

The residue, from a kilogramme of the original material, which remained after treatment with chloride of ammonium and nitric acid, weighed 400 grammes. It was treated as follows, to get the metals in a form adapted to farther chemical treatment.

The method depends upon the behavior of chloride of zinc to zinc. If a piece of zinc be smelted, it rapidly covers itself with a stratum of oxide. If, to the smelted metal, a metal like iridium be added, the oxide stratum hinders the latter from coming into contact with the zinc, even though it be pushed beneath the surface; if, however, a few grains of chloride of ammonium be given to it, ammonia, hydrogen, and chloride of zinc will be formed, which last dissolves the oxide stratum to basic-chloride of zinc. The zinc below resembles mercury in lustre and movability. As soon as the chloride has dissolved as much of the oxide as is possible for it, the oxide stratum again forms, and is instantly removed again by the addition of more chloride of ammonium. The melted zinc (strewn with chloride of ammonium) also possesses, like mercury, the property of attacking other metals, if the affinity exists of forming with them alloys. By strewing chloride of ammonium upon the melted zinc, a quiet surging is kept up as the ammonia and hydrogen are given off. Many oxides and chlorides, among

which are those of the platinum metals, are, when they come into contact with this atmosphere of reducing gases, (and with the basic-chloride of zinc) instantly reduced and dissolved to alloys by the zinc. (We have here a means of separating, quantitatively, all metals which are not dissolved by zinc from those which are.) In making the solution, the zinc, in a porcelain dish, should be constantly rotated: the gangue remains in the basic-chloride. The regulus, immediately upon solidifying, should be taken from the capsule, out of the yet fluid basic-chloride, and washed off with acetic acid until all the basic-chloride is dissolved away. The gangue can be quantitatively determined by filtration and weighing. If the regulus is not immediately removed, the containing vessel will be broken, owing to the unequal expansion of the porcelain and the metal.

The best proportions for a quantitative separation are, to one part of the expected platinum metals, from 20 to 30 parts of zinc; for an ordinary separation, 7 parts of zinc is sufficient.

For the extraction of the residues remaining after our treatment with nitric acid, this method is admirably adapted; by fusing only once with zinc, for two or three hours, all the platinum metals are extracted. The operation is the following:—

From 3 to 3·5 kilogrammes of commercial zinc were fused in a two-litre Hessian crucible, chloride of ammonium, from time to time, strewn upon it, the 400 grammes of residue, previously heated to faint glowing with chloride of ammonium were added, and the temperature kept, for two or three hours, just above the fusing point of the alloy, by adding, whenever the mass threatened to solidify, some chloride of ammonium. The mass is divided into three strata after solidification has taken place.

The *outer* stratum, easily broken away by a blow from a hammer, contains *no* platinum metals. The *next* contains some particles of the zinc and platinum alloy imbedded in the basic-chloride of zinc; it is porous, and not very thick.

The *inner* stratum consists of a frequently beautiful crystalline regulus. To obtain the alloy from the middle stratum, it is only necessary to wash repeatedly with water; and the alloy gained is, of course, to be added to the regulus. To obtain this regulus as pure as possible, it was again fused with 500 grammes of zinc and some chloride of ammonia, then granulated in water, and the granules dissolved in fuming hydrochloric acid. The acid attacks the

regulus with the greatest energy, and the solution was completed in less than an hour. The chlroide of zinc can be used for the next operation.

The platinum metals are found at the bottom of the vessel, in form of a finely divided black powder, and is impurified with zinc, and with traces of iron, copper, &c., from the latter. It cannot be purified with nitric acid, nor with aqua regia, for part of the platinum metals will thereby be dissolved, or, at best, so suspended in the fluid that filtration is impossible. If, however, the powder is treated with hydrochloric acid, singularly enough all the impurities are dissolved, not only zinc and iron, *but also lead and copper dissolve readily with the generation of hydrogen.* The explanation is readily found in electrical currents produced by the contact of the metals, the stream passing from the positive zinc, iron, &c., to the negative platinum metals; hydrogen being given on the latter and chlorine on the former, and uniting with them. The metals (rhodium, iridium, &c.), after thorough washing, weighed 65 grammes. This powder possesses the property, upon being gently heated, of exploding weakly, and, when highly heated, with violence, the explosion being accompanied with the evolution of light, thereby neither hydrogen nor chlorine, nor nitrogen, nor aqueous vapor are given off, and as these are the only elements which it is possible that the metallic powder could have taken up, it must be assumed these metals are, by our treatment, converted into an allotropic condition, and that, upon heating, they return, with more or less energy, to their original condition. The powder contains, mainly, rhodium and iridium, but there are traces present of platinum, palladium, lead, copper, iron, and zinc.

It was intimately mixed with about 3 or 4 times its weight of completely anhydrous chloride of barium, and a stream of chlorine gas lead over it at a tolerably high temperature. The operation is concluded when particles of sesqui-chloride of iron show themselves on the neck of the flasks containing the powder. It is carefully brushed away with filter paper. Some water was now added and the mass of the platinum metals dissolved with the evolution of heat. There remained behind 13·7 grammes of insoluble matter, which, upon reduction with hydrogen, alloying with zinc and treatment with hydrochloric acid, furnished 4·5 grammes of ruthenium. From the original 65 grammes of metal-powder, there was dissolved in three hours, and with the use of four ordinary burners, 57 gram-

mes of the platinum metals, there being consumed thereby 415 grammes of 85 per cent. black oxide of manganese. From this solution all the chloride of barium was removed by careful addition of sulphuric acid (see the precipitation of palladium). The platinum metals were now completely freed from all other metals by reduction with hydrogen (with 100 grammes of material this operation will require five or six days); the temperature being throughout the operation maintained at nearly 100° C., by means of the constant water-bath. Platinum and palladium chiefly, separate first, then mainly rhodium, and the last portions consist almost entirely of iridium. It is best to break off the operation when the fluid has assumed a greenish-yellow color. The last portions of iridium (obtained by evaporating the solution to dryness, fusing with carbonate of soda, and treatment with aqua regia) were added to the portion, afterward to be again rendered workable by renewed treatment with chloride of barium. The operation of reduction is hastened by concentrating the fluid, in doing which, care must be taken to guard against explosion on account of the hydrogen. The separated metals were treated with aqua regia and the platinum and palladium thus dissolved, were separated from each other as above described. The traces of rhodium and iridium in the mother-liquid can be removed entirely by continued boiling with iodide of potassium, (whereby they precipitate as iodides,) dissolved in aqua regia, and added insoluble portion.

This insoluble and partly oxidized portion was now again reduced in hydrogen gas, treated, as before described, with chloride of barium, and after the removal of the barium, the last traces of platinum and palladium removed by boiling with caustic soda. Rhodium and iridium now alone remain to be separated.

The brown-red fluid was, for this purpose, evaporated with hydrochloric acid, and, after filtration, treated with bisulphite of soda, $\left(\begin{matrix}NaO\\HO\end{matrix}\right\}S_2O_4\Big)$ in *great excess*, and the whole allowed to remain quietly *in the cold* for several days. The double salt of rhodium ($NaO.\ SO_2$, $RhO\ SO_2$) separates slowly, giving a lemon-yellow precipitate. The solution becomes lighter and lighter and finally almost colorless. The color of the precipitate changes with that of the fluid, becoming with it, lighter. This precipitate upon washing, contained the rhodium almost pure.

Upon heating the fluid gently, a yellow-white precipitate sepa-

rated, which consisted mainly of rhodium, but contained also some iridium. After filtering off this precipitate, the solution upon being concentrated to a small volume gave yet two precipitates:—

1st. A curdy, slowly separating, yellowish-white precipitate, nearly chemically pure iridium, containing but the faintest traces of rhodium.

2d. A heavy, crystalline powder, quickly separating, which was readily freed from the first by decantation, and weighed 16 grms. Upon testing, it gave all the reactions for iridium, but likewise some peculiar reactions not shown by the latter; it may possibly contain a new metal.

Exclusive of these 16 grms, the precipitate (the 1st.) weighed 99·5 grms. The mother-liquid was free from platinum metals. The complete separation of rhodium from iridium was accomplished by treating the yellow precipitates with concentrated sulphuric acid. They were brought in small portions into the acid, heated in a porcelain capsule, until all the sulphurous acid had escaped, and then left upon the sand-bath, until all the free sulphuric acid had been driven off; and the sulphate of soda formed. Upon boiling the mass of water, all the iridium dissolves as sulphate, with a chrome-green color, while the rhodium remains behind as a flesh-red double salt of soda and rhodium oxide. It (the latter) was washed by boiling in aqua regia and decanted with water. It is insoluble in water, hydrochloric or nitric acids and in aqua regia. The rhodium and iridium are now completely separated. The rhodium salt weighed 33·2 grms.

The following are the weights of the various precipitates obtained from one kilogramme of the original residue:

$K\,Cl, Pt\,Cl_2$	= 117·5 grms.
$Pd\,I$	= 77·0 "
$K\,Cl, Pd\,Cl$	= 19·0 "
$NaO\,SO_3, RhO.\,SO_3$	= 33·2 "
$Ir_2\,O_3$	= 9·1 "
Ru. (+ Ir.)	= 4·5 "

The first yellow precipitate, obtained in the cold, by the bisulphite of soda, gave by this treatment, the rhodium quite pure. The second and third precipitates containing much iridium gave a very fine rhodium, but still slightly impurified with iridium. The products, therefore obtained by this treatment with sulphuric acid (which betray their impurification from iridium by their somewhat brownish color) were collected for themselves. The rhodium sepa-

rated therefrom by glowing, treated again with chloride of barium, and the operation of separation repeated. The green solution containing only iridium was gradually heated over an ordinary burner, in a porcelain capsule, and afterward upon the sand-bath, to remove the excess of sulphuric acid; and finally the capsule and its contents were highly treated in a Hessian crucible. There is formed thereby sulphate of soda and sesquioxide of iridium. Upon boiling the mass with water, the last remained behind as a black, insoluble powder, which was readily washed by decantation. It weighed 9·1 grms.

In these operations, the new filtering apparatus and the continuous water-bath, with which I have furnished my laboratory, materially shortened the labor.

THE MELBOURNE TELESCOPE—REPORT OF COMMITTEE.

THE Committee were informed by Mr. Grubb at the close of last year that the telescope was ready for their final examination; but the bad weather which has prevailed in Ireland ever since precluded all trials of its optical power till February 17, when they met at Mr. Grubb's works in Rathmines Road.

1. The telescope was not finished at the time named in the contract; but the Committee have ascertained that the delay arose solely from unfavorable weather, which not only impeded the actual work of polishing, but for weeks together made it impossible to test the figure of the specula. They considered that it was far more important to send out a perfect instrument than to keep the exact time.

2. The Committee, after minutely and carefully studying the mechanical details of the equatorial, have come unanimously to the conclusion that it is a masterpiece of engineering. Its movements are surprisingly smooth and steady; it can be moved to any portion of the sky, even if it have to be reversed from one side of its pier to the other, in less than a minute by two operators, and with very little exertion.

The clock is smooth and equable in its action, it is very powerful, and quite equal to its work. Great change of rate, as from sidereal to lunar time, is effected by an ingenious piece of differential gearing; small changes are made by a cam adjustment; more-

over, it rings seconds, for the double object of comparing its rate with a chronometer, and to assist the observer in his observations.

3. The Committee are strongly impressed by the great convenience to the observer of the arrangements of the hour and polar-distance circles, the facility of controlling their adjustment, and the easy access to the eye-piece.

4. The stability of the tube was severely tested, both in respect of its general stiffness and its power of resisting torsion, such as might be produced by the weight of the small speculum when the telescope is off the meridian; and the results were highly satisfactory.

5. In large reflecting telescopes it is usual to make provision for keeping a given diameter of the great speculum always in a vertical plane. When they are equatorially mounted, this is done by rotating the tube in its cradle. Here the tube does not turn; but there is a special arrangement of hoop-suspension, by which, whatever diameter may be vertical, it is supported in a uniform and symmetrical manner. The system of triangular levers at the back of the great speculum is also contrived so as to prevent them from exerting any pressure which might distort it. This is a matter of the highest importance, and the attention of the Committee was specially directed to it. They examined it most carefully, putting the telescope in various positions of R.A and P. D. on each side of the meridian, both by day and night, and could not find *any sign of flexure or any distortion of the image in any of these changes.*

6. In order to test the optical power of the second speculum B (the first one A, had been tried and approved by a member of the Committee on October 12 last), the telescope was directed to the following objects:—In the daytime Venus and α Andromedæ; at night (which fortunately was clear and steady) Castor, the Great Nebula of Orion, ζ Orionis, γ Andromedæ, Uranus, 1 Messier, 37 Messier, 46 Messier, and 51 Messier, from which it will be seen that both the light-collecting and defining powers of the instrument were fairly tried. The powers used were 220 (the lowest which can take in the entire pencil), 350, and 450, all negatives. Of course one would not propose such an instrument for the measurement of close double stars, work for which telescopes such as those of Poulkova and Harvard are possibly better fitted; but the Committee found that the light even of large stars was collected into small, hard, and perfectly circular disks, free from rays; and though some diffused light* surrounded them, it was exactly concentric with the central

* The cause of this diffused light has since been discovered and removed.

disks. The 5th and 6th stars of the Trapezium of Orion were not only plainly seen, but were very bright; ζ Orionis was well shown, and the companion of γ Andromedæ was clearly divided with the powers of 350 and 450, and the different tints of the components were evident. Uranus was well seen, but was surrounded by such a multitude of very minute stars that, without access to the tables of his satellites, it was impossible to know whether any of them were seen.* 37 M. was broken into a heap of stars so large and brilliant that it quite lost the character of a cluster. The planetary Nebula in 46 M. brought out most strikingly the light-collecting power of this telescope; for it (which in most telescopes appears as a faint disk) was revealed as a ring, bright even on the dazzling ground of the surrounding stars, which here were as brilliant as the components of the Pleiades appear in ordinary instruments. With respect to the Nebulæ, it is needless to say more than that Lord Rosse considers its performance in bringing out the details of the Orion Nebula, 1 M. (the Crab), and 51 M. (the Great Spiral), quite satisfactory.

7. The Committee had no opportunity of testing the spectroscope on stellar or nebular spectra; but they have tried it on solar and electric ones, and consider that it will be very effective, from the solidity of its structure, and its large dispersion combined with a small deviation.

8. The balance of the grant, which will probably be absorbed by the expense of packing the instrument for removal, was not sufficient to justify the Committee in ordering a photographic apparatus which should be worthy of the telescope; but some trials have been made with a "makeshift affair," which confirm them in their opinion that it is most important to turn to account the photographic power of this magnificent instrument, not only for the moon, but for the planets *and the sun*. On two or three occasions Castor and the moon were taken with this temporary apparatus; as to the star, its components impressed their images in good measurable disks in times varying from two to eight seconds; with respect to the moon, on February 1, when she was seven days old, and the air good, a remarkably hard and sharp picture, full of minute details,

* On the 19th of February, however, the Committee had the advantage of the presence of Mr. Lassell in the examination of Uranus among other objects with Speculum A, and, guided by his familiarity with that object, they were enabled to make out stars, the positions of which, with great probability, corresponded to the places of the two most distant, and one of the nearest satellites.

was obtained, which exhibits so strongly the great photographic power of the instrument, that they would regard it as a serious loss to science if this was not most fully brought into action. This is the more desirable because lunar and solar photography would utilize a considerable portion of time, during which the observing of nebulæ is impossible. After full inquiry, the Committee find that the cost of the necessary apparatus for this work, including a micrometer for measuring distances and positions on the photographs (like that described in the *Phil. Trans.*, 1862, p. 373), could be provided for a sum not exceeding £400; and they earnestly hope that so valuable an addition may be made. They have been given to understand that the Melbourne Government have resolved on putting a roof over the instrument, but that they think it can be more economically constructed there than here. In this case, it occurs to the Committee that the second form of roof described in Dr. Robinson's letter might be preferable to the more complex one there recommended; and as it would be less costly, the difference would more than cover the expense of the photographic apparatus. In this hope they have directed Mr. Grubb to prepare a detailed plan of that apparatus and of the second form of roof. The Committee conclude by stating that they have no hesitation in declaring that the instrument is perfectly fit for the work for which it was destined. They therefore consider that Mr. Grubb has fulfilled his contract, and have directed him to lose no time in preparing the necessary cases and packing it for Melbourne. They have also instructed him to insure it against the risk of fire during its stay.

The Committee feel bound to say that Mr. Grubb has put a most liberal construction on the terms of his contract; and after their minute examination of the excellence of the telescope, and the amount and perfection of the machinery connected with it and its manufacture, they are convinced that Mr. Grubb has been more influenced by the desire of producing a perfect instrument than by any prospect of pecuniary advantage, and can scarcely realize the possibility of giving so much for the sum named in the contract, especially when it is considered that special works had to be erected for the purpose of constructing the telescope.

ROSSE,
T. R. ROBINSON, D.D.
Feb. 19, 1868. WARREN DE LA RUE.

P. S. March 7th, 1868.—I would strongly recommend that the photographic apparatus should be fitted to the telescope before it leaves Ireland. WARREN DE LA RUE.

ON A NEW SPECTROSCOPE, WITH CONTRIBUTIONS TO THE SPECTRAL ANALYSIS OF THE STARS.

By Prof. J. C. F. Zöllner.

From the Reports of the Royal Saxon Academy of Sciences, Leipsic, Feb. 6, 1869. Translated from No. 1772 (Sept. 15, 1869) of the *Astronomische Nachrichten*, by Prof. Alfred M. Mayer, Ph. D.

The spectral analysis of the stars, apart from the information which it gives concerning the physical constitution of heavenly bodies, has of late attracted considerable attention in another and not less interesting direction. There is a prospect of our being able by means of it to prove, and even to measure, the influence which the component of the relative motion of the earth and of the observed star, acting along the line joining them, exerts upon the position of the spectral lines.

It is clear that the influence which two separated bodies exert upon one another, by periodical impulses of finite velocity of propagation, must be modified by a constant change in the distance of the two bodies. Doppler has the merit of having first perceived the necessity of such an influence, in 1841, although his conclusions concerning the colors of the stars must be considered incorrect, because he neglected to consider the invisible portions of the spectrum.

Numerous experiments, by Ballot, Mach and others, have proved with reference to *sound* that the above influence is in accordance with the demands of theory.

With reference to *light*, however, it has not been possible hitherto to detect by observation such magnitudes of this influence as could be clearly demonstrated; because even the cosmical motions which are the most rapid at our command, are very slow when compared with the velocity of light.

The great improvements made in the optical instruments since the discovery of the spectral analysis, give us the hope of showing the above influence in the spectra of the stars. According to theory this influence must show itself in the displacement of the spectral lines. The amount of this displacement would be one-tenth of the distance between the two sodium lines, for the mean velocity of the earth, of 4 German miles a second.

This amount, which can be very easily calculated from the velocity of light and the duration of the undulations of the rays produc-

ing the soda lines, has very recently been again computed by J. C. Maxwell, in accordance with the former calculations of F. Eisenlohr and others.

The amount of the displacement seemed to Maxwell to be so small, that he closes his remarks with reference to the present form of the spectroscope and to the method of determining the position of the lines, as follows: "It cannot be determined by spectroscopic observations with our present instruments and it need not be considered in the discussion of our observations."

Huggins has, nevertheless, in his latest treatise, containing the experiments of Maxwell, attempted to solve the problem by the use of a spectroscope consisting of not less than 5 prisms, of which 2 were flint glass *Amici's*, and 3 crown glass prisms.

The loss of light, caused by the large number of prisms, permitted him only to observe the brightest stars. He confines his communications to a statement of the results of his observations on Sirius, and thinks that he has found a slight displacement of the line *F*, as compared with the hydrogen line produced by a Geissler's tube.

The direction and amount of the displacement would indicate an increase of the distance between the earth and Sirius with a velocity of 41·1 English miles per second.

If the components of the motion of the earth, which amounted at the time of observation to 12 English miles, are eliminated, the velocity with which Sirius and the sun separate from one another would equal 29·4 English or about 6·4 German miles.

Huggins himself considers this result as very uncertain, partially on account of the above mentioned great loss of light, and partially on account of the difficulty of comparing the coincidences of the *bright* lines from terrestrial sources of light, with the *dark* ones in the sidereal spectra. Sometimes the latter also have a different appearance, *e. g.* they may be blurred and of different width, as is the case in the line *F* of the spectrum of Sirius.

I think that I have overcome the most material of these difficulties which have hitherto impeded the solution of the problem, by means of a spectroscope of new construction, the first specimen of which I have the honor of placing before the Royal Society.

The construction is as follows: The line of light produced by a slit or by a cylindrical lens is in the focus of a lens, which makes the rays parallel as in other spectroscopes. Then the rays pass through two

Amici's systems of prisms, *à vision directe*, which I have received from Mr. Merz, Munich.

These are so placed side by side that each gives passage to one-half of the rays coming from the object-glass of the collimator, but so that the refracting edges lie on opposite sides. By this means all the rays are separated into two spectra of opposite direction. The object-glass of the telescope, which unites the rays again to one image, is cut perpendicular to the horizontal refracting edges of the prisms, as in the heliometer, so that each half can be micrometrically moved either parallel or perpendicular to the line of bisection. By this means we are enabled not only to make the lines of both spectra coincide, but to place the two spectra side by side instead of superposing them (so that one is placed beside the other like a *nonius*) and also to partially superpose them. By this construction the sensitiveness of the double image is not only turned to account for determining any change of position in the spectral lines, *but every such change is also doubled* because the influence acts in opposite direction in the two spectra.

The principle of the *reversion of the spectra* which forms the basis of the instrument and which determines me to give it the name of

Reversion-Spectroscope

may also be applied without the use of the *Amici* system of prisms. It is only necessary to reverse a portion of the rays passing through a common prism by means of reflection by mirror or prism, and then to observe the whole pencil of rays with the bisected object-glass of a telescope, as above. The principle also renders the introduction of artificial sources of light for the examination of slight changes of refrangibility entirely dispensable, and allows their detection and determination by the change of position of perfectly similar objects.

The measurements made on the dark (*D*) lines of the sun's spectrum, as well as on the light soda lines of a candle-flame impregnated with common salt, which are given here to enable you to judge of the power of the instrument, justify the hope that we may be able, by means of this spectroscope, not only to observe the influence of the earth's motion, but also to determine it quantitatively, with such precision as is desirable for the preliminary control of theoretical conclusions.

The figures given refer to parts of the micrometer screw, and show the separation of the two soda lines.

Soda Flame.	Sun.
49·5	49·5
50·5	51·5
53·0	48·1
49·5	48·9
Mean .....50·6 ± 0·6	Mean .....49·6 ± 0·5

In the following series of observations, the reversion-spectroscope was provided not only with another micrometer screw with a somewhat coarser thread, but also with two other systems of prisms, whose dispersion in the region of the soda line, was 1·77 times greater than that of the prisms used above. The achromatic object-glass of the collimator, and of the telescope, were also replaced by non-achromatic glasses, by which the sharpness of the images was not impaired, and the clearness and strength of the light were increased.

SUN.

Parts of the Screw.	Deviations from the Mean.
67·1	— 0·8
69·4	+ 1·5
68·4	+ 0·5
67·9	0·0
66·6	— 1·3
66·1	— 1·8
68·2	+ 0·3
68·0	+ 0·1
69·6	+ 1·7
Mean .....67·9 ± 0·3	

The distance between the two *D* lines is, therefore, exactly determined, with the exception of a probable error of $_2\frac{1}{2}{}_6$. According to the above, however, a change of the distance between the source of light and the spectroscope, with a velocity of 4 miles a second, would produce a mutual displacement of the lines of both spectra, equal to $\frac{1}{5}$ of that distance, a magnitude about 40 times greater than the probable error in the mean of 9 readings.

If, in the observation of the spectra of stars, a sufficient amount of light can be employed, we can definitely decide, by the above means, whether or not the expected displacement of the spectral lines occurs. As regards the amount of light necessary, I may observe, that I use a non-achromatic lens of 1 Paris foot diameter and 6 feet focus. The rays from this lens are caught by a concave meniscus of flint-glass, a few inches before the point where they meet, and are thus led into the slit of the spectroscope, as free as possible from spherical and chromatic aberration. I think it necessary to call especial attention to the fact, that it is immaterial whether the image is achromatic or not when a slit is used, especially if only parts of the spectrum are observed. On this account, the above construction is preferable to one with powerful achromatic lenses, as being less expensive. It is, however, inapplicable when, as is the case with double stars, the bodies observed must be separated as sharply as possible.

Finally, I may be allowed to make a few remarks on problems and methods concerning the spectral observations of the sun, in which I am at present engaged.

The velocity of rotation of the sun is such that a point of its equator moves with a rapidity of about 0·25 German miles per second. If, now, we obtain by means of a heliometer, or in some other way, a double image of the sun, and two points of the equatorial edge are made to touch, then parts of the sun's surface at the point of contact will approach us with the given velocity, while others will recede from us with the same velocity. This will produce a difference of velocity of the parts in contact in the line of vision amounting to about half a German mile. According to what has been said above, such a velocity would make a change in the position of the soda lines amounting to the 80th part of the distance between them. In order, therefore, to detect and measure this change by means of a sufficient number of prisms, it is only necessary to bring the centre-line of the slit of the spectroscope into the line of the centres of the two images of the sun, and we shall see the two spectra of the edges in contact, side by side, in the field of vision of the spectroscope, and thus observe the displacement in question under the most favorable circumstances. In this manner the position of the sun's equator, and, if the displacement can be measured, the rotary velocity of different heliographic latitudes could be determined, which

would be of the highest interest, with respect to the latest opinions on the subject.

Even disregarding the quantitative determination of the phenomenon in question, the mere qualitative proof would afford a simple means of *separating all lines produced in the sun's spectrum by the absorption of the earth's atmosphere from those which owe their origin to the solar atmosphere*, since the displacement can obviously extend only to the latter.

Another subject for spectroscopic research are the protuberances of the sun. Lockyer and Janssen were the first who succeeded in observing the spectrum of the protuberances (which consists of three bright lines) independently of a total eclipse.

At present, exertions are made to devise methods for observing not only these lines, but also the whole shape of the protuberances together.

The length of the bright lines corresponds to the size of the protuberance in the direction of the slit. If, therefore, the slit is brought successively in different positions, so that it cuts the protuberance in many directions, we can construct the shape of the latter, as, indeed, Lockyer has already done. Based upon this principle, Janssen proposes to construct a rotating spectroscope, so that the whole shape of the protuberance can be seen at one glance when the spectroscope is revolved with sufficient rapidity.

Apart from the mechanical difficulties of such a rotating spectroscope, in which one of the three bright lines must lie exactly in the axis of rotation, the end in view can be more easily and perfectly attained by making the slit oscillate perpendicularly to its direction. In this way we could observe the same protuberance simultaneously in three differently colored images, corresponding to the three different lines of its spectrum.

According to these methods, with a movable slit, the brightness would be diminished in proportion to the distance traveled over by the slit. Especially in the rotating spectroscope, the brightness of the protuberance itself would decrease from the centre of rotation to the edge, and thus prevent the observation of the natural brightness of its parts.

For this reason, I intend to employ another very simple arrangement. I have convinced myself of its practicability by the experiments on terrestrial sources of light described below. The principles upon which it is based are as follows:—

1. The apparent brightness (lustre, *claritas visa*) of a protuberance-band is independent of the opening of the slit, provided that it retains an appreciable breadth on the retina.

2. The brightness of the superposed spectrum increases in proportion to the width of the slit.

3. In oscillating or rotating slits the brightness of the superposed spectrum remains unchanged, while that of the image of the protuberance produced by the permanence of the light, decreases according to another law, depending upon the number and duration of the impressions on the retina, and on the refrangibility of the observed band of the protuberance.

If, for simplicity, we suppose that the whole surface over which the slit travels in its rotation or oscillation is filled with the protuberance, and that the intensity of the produced secondary image is in inverse ratio to that surface (corresponding to a uniform diffusion of the light over that surface through a *stationary* slit), then the relation of the intensity of the background to that of the protuberance would remain the same, whether we

First, decrease the brightness of the protuberance by means of *oscillation* of the slit, and thereby leave the brightness of the superposed spectrum or background (according to 2) unchanged, or

Secondly, open the stationary slit so widely that the opening extends over the space traveled over by the oscillation of the slit in the first case. By this means (according to 1), the apparent brightness of the protuberance remains unchanged, while that of the background is increased in the same ratio in which it was diminished before with a constant background.

If these suppositions are correct, the end in view can be much more easily attained in the second way, if we take care not to admit the intense light of the body of the sun into the slit.

It is only necessary to open the slit so far that the protuberance, or a portion of it, appears in the opening. By polarizing or absorbing media, placed before the eye-piece, the light in the whole field of view, can be so diminished that the proper relation of intensity between the protuberance and the superposed spectrum may be obtained.

Led by these considerations, I have tried to realize the circumstances under which the protuberances are visible, with the aid of terrestrial sources of light, in order to test both methods, and convince myself of their practicability. The following observation is necessary to the better understanding of these experiments.

The reason why the protuberances are not visible on diaphragming off the intense image of the sun is, that strongly illuminated portions of our atmosphere lie above and cover the image of the protuberances. In a total eclipse of the sun this illumination is so considerably weakened that the intensely luminous protuberances stand out from the illuminated portions of the corona. How much the diffused light of our atmosphere is weakened is seen in the fact that its mean strength is about equal to that of the full moon. According to my photometric measurements, this illumination is 618,000 times less than that produced by the sun. Therefore, the selective absorption of colored media must be in the same relation to the homogeneous light of the protuberances, if, as has been attempted, we try to make the protuberances visible in this way without dispersion.

On the other hand, the possibility of accomplishing our object by means of the prism, by the dispersion of the superposed atmospheric light, rests mainly upon the fact that this light is composed of rays of all degrees of refrangibility, while that of the protuberances consists only of 3 kinds of rays.

I have artificially produced the superposition of a non-homogeneous mass of light on a body of well-defined outline, and shining with a homogeneous light, in the following way:—

The wick of an alcohol flame was impregnated with common salt and chloride of lithium. At a distance of 18 feet from this flame, plate of glass was placed at an angle of 45° to the line of observation, so that the reflected image of a petroleum flame covered weak alcohol flame, and rendered it entirely invisible by its greater intensity. About 1 foot from the mirror was a small lens, of 6-inch focus, which threw a small image of the alcohol flame into the slit of the spectroscope. The latter was fastened, at one end, to a spring 10 inches long, so that, by disturbing its equilibrium, oscillations of sufficient amplitude would be produced for the space of about 5 minutes.

Then the width of the slit was so far diminished that the double line, *D*, and the lithia line (although proportionally weaker) appeared sharply defined in the field, when the apparatus was at rest. As soon as the oscillations commenced, these lines were converted into sharp images of the alcohol flame, and the two soda images overlapped about one-half. These three images were less bright than the three light lines, and, consequently, their contrast with

the diffusely illuminated background of the spectrum was also proportionally less marked than that of the lines when the slit was stationary.

As soon as I tried the second of the above methods by opening the slit (keeping the apparatus at rest) so far that the image of the alcohol flame was just enclosed by the rectangular opening of the slit, I was astonished at the far greater beauty and clearness of the contrast of the images with the background.

It seems, therefore, that there is a greater loss of light when an oscillating slit is used than in the latter method.

As will be readily seen, there is no principle which will prevent the application of this method to the observation of the protuberances (the author has not yet had the opportunity of doing so) With the given relation of intensity between the homogeneous light of the protuberances and that of the superposed atmosphere, the practical success depends merely on the question whether a sufficiently strong dispersion can be effected. If the intensity and clearness of the protuberance lines observed by me at the Berlin Observatory on the 24th of December, 1868, warrant the conclusion that the light of the protuberances is relatively of considerable intensity, then the *four* excellent systems of prisms at present in my possession will probably enable me to solve the problem of the visibility of the protuberances in a satisfactory manner, according to the method described.

APPENDIX.

Being informed that Mr. Lockyer has succeeded in observing the protuberances by means of a spectroscope with 7 prisms, I will make the following additional statements:—

The spectroscope, which was made according to my direction, by Tauber, of Leipsic, contains but *one* prism, *à vision directe*, by *Merz*. It was attached to the 6-foot Fraunhofer's Refractor, of this Observatory. The height of the slit was 6′ 20″, and the opening varied according to the height and size of the observed protuberance. It is most advantageous to make the length of the slit a tangent to the edge of the sun. In this way we see more of the edge at once, and we are also enabled to determine the angle of position of the protuberance more exactly, since the sun's first entrance in the slit produces a flash of a narrow tape-like spectrum in the middle of the field of view. The point where this flash appears can be easily

brought to the place of the protuberance by turning the spectroscope around the axis of its length, and the slit then forms a tangent to that spot of the sun's edge which is occupied by the protuberance. The position of the spectroscope can then be read off on a graduated circle, and thus gives the angle of position of the protuberance.

We may avail ourselves of two different methods of bringing the different points of the sun's edge into the slit. According to one, the object glass of the refractor is so fastened in a ring that its optical axis is inclined about 15′ to the longitudinal axis of the tube. If this ring is turned, by means of a screw on the tube, the optical axis of the object-glass will describe a cone of about 30′ aperture, so that different portions of the sun's edge are brought successively into the focus before the centre of the slit. Of course, the position of the latter must be varied in a corresponding manner by turning the spectroscope.

According to the other method, which has the advantage of an unchanged position of the slit, the rays are passed through a so-called reversion-prism before they unite to form an image. If this prism is turned about the axis of the instrument, the image of the sun will also rotate about its centre, and thus allow different portions of its edge to fall successively upon the slit. The angle of position is then determined by the position of the prism of reversion.

The size of the image of the sun in the refractor, or, in other words, the focal distance of the object-glass used, plays a very important part in the whole method. From the theory of the method stated above, it follows that with the same spectroscope the contrast between the protuberance and the background depends solely on the opening of the slit. Since, with a constant aperture, the smaller the sun's image, the greater the portion of the protuberance seen at once, it follows that we must not seek to magnify the protuberance to be observed by means of the sun's image, *i. e.*, by a large focal distance of the object-glass of the refractor, but by the arrangement of the lenses of the spectroscope. It can easily be accomplished by using a collimator with a small focal distance in comparison to that of the telescope. Suppose we have a refractor of 10 feet focal distance, to be used in conjunction with a spectroscope in which the focal distances of both object-glasses are equal. If it is now necessary to open the slit until the aperture is one millimetre, in order to observe a protuberance of a certain size, this

opening could be reduced to $\frac{1}{10}$ millimetre, if the image of the sun were only $\frac{1}{10}$ as large, which would still leave the whole of the protuberance visible while giving it a ten-fold greater contrast with the background of the spectrum. Now, in order to magnify the protuberance in the *field of view*, so as to make up for what it lost by reducing the size of the sun's image, it is only necessary to make the focal distance of the collimator 10 times shorter than that of the spectroscope. Using the same illustration, we would obtain an effect 10 times better with *the same optical magnifying power and the same system of prisms* if instead of a 10-foot refractor, a telescope of only 1 foot focal distance were used, making the focal distance of the collimator about 2 inches and that of the observing telescope 20 inches. The excellence of the images is very little influenced by the system of lenses, since the errors from chromatic observation entirely disappear on account of the homogeneous nature of the light of the protuberance. For this reason, as I have convinced myself by numerous experiments, non-achromatic lenses can be used for such combinations. The extraordinarily small space into which the instruments for the observation of the sun's protuberances can be brought by this means, allows the employment of finely-regulated clock-work, and thus opens the prospect of producing *an artificial total eclipse of the sun of any desired duration for the simultaneous observation of all the protuberances on the sun's edge.*

Coloring of Small Metallic Objects.—M. Pusher makes a solution of four ounces of hyposulphite of soda in a pint and a half of water, and adds a solution of one ounce of acetate of lead in the same quantity of water. Articles to be colored are placed in the mixture, which is then gradually heated to a boiling point. The effect of this solution is to give iron the effect of blue steel, zinc becomes bronze, and copper or brass becomes successively yellowish red, scarlet, deep blue, bluish white, and finally white with a tinge of rose. This solution has no effect on lead or tin. By replacing the acetate of lead in the solution by sulphate of copper, brass becomes of a fine rosy tint, then green, and finally, of an iridescent brown color. Zinc does not color in this solution, it throws down a precipitate of brown sulphuret of copper, but if boiled in a solution containing both lead and copper, it becomes covered with a black crust, which may be improved by a thin coating of wax. If the lead solution be thickened with a little gum tragacanth, and patterns be traced with it on brass, which is afterwards heated to 212°, and then plunged into solution No. 1 a good effect is produced.

SPECTROSCOPIC NOTES.

By Prof. C. A. Young, of Dartmouth College.

Observations on the Solar Prominences.

Sept. 16th, 1869.—2 to 3.30 P. M. Clear and calm. Protuberances were observed on the sun's limb as follows:

No.	Position.	Solar Latitude.	Height.	Remarks.
1	0°	+ 64°	20″	
2	70	+ 46	35	
3	132	— 16	15	Small, but very bright.
4	160	— 44	20	Small and faint.
5	175	— 59	60	Faint.
6	238	— 52	20	
7	337	+ 41	45	Pretty bright.

Sept. 24th.—1.50 to 4 P.M. Flying clouds and a fresh breeze. Protuberances noted as follows:

No.	Position.	Latitude.	Height.	Remarks.
1	65°	+ 52°	15″	Bright.
2	90	+ 27	30	"
3	102	+ 15	35	Faint.
4	150	— 33	65	Diffuse and nebulous; rather faint.
5	165	— 48	55	Of medium brightness.
6	240	— 56	35	45″ long. Nebulous and diffuse.
7	250	— 46	15	Pyramidal and well defined.
8	285	— 12	20	Bright. Mushroom formed.
9	342° to 355°	+ 45° to 58°	45″ to 70″	Large and bright, 3 distinct peaks.

On the eastern limb (position-angle 97°) there was a spot within 10″ of the edge of the disc. There was no prominence over or very near it, but if anything the chromosphere was somewhat shallower just at that point.

At 2.50 P. M. a distortion of the F line was noticed at a point on the sun's disc about 30″ from the edge, and some 20″ east of an extensive cluster of spots near the eastern limb.

At one time there was a little bulb attached by a short ligament to the upper (more refrangible) edge of the line, and extending distinctly beyond the fine iron line which lies just above it. Some 10″ below the bulb there was a small lump on its other edge, and between them it was irregularly thickened. Fig. 12 represents the appearance of F during the phenomenon.

Fig. 12.

The bulb lasted only about *one* minute, but more or less deformation of the line was evident for about *ten* minutes, and was observed also on the C line though not so clearly. It could not be detected in D_3 (1017·5).

The observations this day were somewhat interfered with by the clouds, and still more by the wind, which at times made the instrument so unsteady as to render the determination of the position-angles uncertain, possibly to the extent of 10° in the worst cases.

Sept. 28th.—5 to 5.30 P. M.

No.	Position.	Latitude.	Height.	Remarks.
1	60°	+ 57°	20″	
2	163	— 46	45	
3	172	— 55	35	Fig. 10, Plate I. Very bright.
4	215	— 62	30	
5	345	+ 48	120	Faint and diffuse.

No. 3 was intensely bright and of very curious form, much like the gable end of a roof. I have endeavored to represent it in Fig. 10, Plate I. It was probably formed by two pillars of flame (?) standing at opposite angles of inclination one behind the other, in this respect imitating the structure of the "antelope horn" protuberance, which was so conspicuous on the eastern limb of the sun during the late eclipse.

Sept. 30th.—3.45 to 5 P. M. Air hazy.

No.	Position.	Latitude.	Height.	Remarks.
1	65°	+ 53°	35″	A little horn, inclined 45° towards the south.
2	85	+ 33	30	
3	92	+ 26	20	
4	105	+ 13	30	
5	175	— 57	30	
6	230	— 68	45	Brilliant, Fig. 13.
7	247	— 51	35	Faint, a cumulus lump.
8	267	— 31	60	Bright, double, Fig. 14.

Fig. 13, No. 6, Sept. 28th.

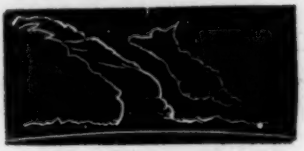


Fig. 14, No. 8, Sept. 28th.

Oct. 1st.—2 to 4.15 P. M. Flying clouds troublesome.

No.	Position.	Latitude.	Height.	Remarks.
1	75°	+ 43°	65″	Bright at base.
2	150	— 32	35	Brilliant.
3	165	— 47	60	Faint.
4	232	— 66	45	
5	245	— 53	60	Clouds interfered.
6	270	— 28	30	Faint, mushroom shaped, Fig. 15.
7	335	+ 37	55	Bright, Fig. 16.

Fig. 15, No. 6, Oct. 1st.

Fig. 16, No. 7, Oct. 1st.

Oct. 2d—2 to 3.15. Too windy for satisfactory work.

No.	Position.	Latitude.	Height	Remarks.
1	70° to 80°	+ 38° to 48°	30″ to 35″	Extensive range, bright at points.
2	118°		35	Faint.
3	150	— 32	....	A detached cloud 25″ above limb, 20″ diameter, Fig. 17.
4	237 to 242	— 56 to 61	45	Length 90″.
5	276	— 22	35 to 60	Double headed.
6	340	+ 42	75	A vertical pillar.

Fig. 17. No. 3, Oct. 2d.

Of these, Nos. 1, 3 and 7 are evidently the same with Nos. 1, 2 and 6 of the preceding day. It is doubtful whether No. 4 can be identified with either 4 or 5 of Oct. 1st.

Oct. 7th.—1.30 to 4.15 P. M. Everything favorable to observation.

No.	Position.	Latitude.	Height.	Remarks.
1	70° to 78°	+ 40° to 48°	120″	Enormous. Fig. 5, Plate I.
2	90 to 95	+ 23 to 28	45	Faint.
3	100	+ 18	25	Very small and faint.
4	125	— 7	75	Magnificent, Pl. I, Figs. 1, 2, 3 & 4.
5	145 to 150	—27 and 32	30 and 35	Two small curved horns.
6	183	— 65	20	Small but brilliant peak.
7	264	— 34	15	Surrounded by nebulosity.
8	280	— 18	60	Pretty bright. Hazy.
9	316	+ 18	25	Long low mass of cumulo-stratus.
10	332	+ 34	.....	Small horizontal cloud 15″ above the limb, 15″ by 5″.
11	355	+ 57	45	Brilliant and of curious form. Plate I, Fig 9.

Several of the prominences observed this day were very remarkable. No 1 was of enormous magnitude and singular form, which I have endeavored to represent in Plate I., Fig. 5, (taken at 2.45.) The structure of the large faint mass was rather cumulus except upon the following edge, which was more filamentary and cirrus. The smaller but much more brilliant peak was very like the flame of a bonfire in its general appearance. No. 11, represented in Fig. 9, Plate I., was noticeable for its brilliance and the verticality of its component filaments. This was in striking contrast with the structure of No. 4 in which the elementary flocculi were nearly horizontal. This latter protuberance, taking everything into account, its magnitude, brightness, the rapidity of its changes, and their suggestive character, was the most remarkable I have yet observed, with perhaps one exception. Fig. 1, Plate I., delineates its appearance at 2.20 P. M. Fifteen minutes later, accidentally returning to it, I was astonished to find it as represented in Fig. 2, and while I was sketching it, unless my eyes greatly deceived me, the pointed extremity *flickered back and forth to the extent of* 5″ (2,250 *miles*) *in as many seconds of time.* The motion was both lateral and longitudinal like a tongue of flame, not apparently a mere pulsation of light. I record this with some misgiving, knowing how easily the eye may be cheated by the imagination, but at the time the impression was one of certainty. Fig. 3 shows the

appearance of the prominence at 2.55. The little projections from the chromosphere are nearly gone, and the cloud, which floated above, has united with the main body. Fig. 4 was taken at 3.30; the prominence then was certainly not more than one-fourth as brilliant as when first observed. (On the next day, as will be seen, it was hardly visible.) At 3 it distinctly reversed the two magnesium lines b_1 and b_2 for about 10″ in its stem. It also showed a bright line clear and unmistakable at K 2581·5, as determined by direct reference to Kirchhoff's map. It was *not* the upper magnesium line, which is situated at 2567, nor could I make out any bright line there.

This observation has led me to doubt whether the line given in my eclipse report at K 2602 is rightly placed. A correction of one revolution of the micrometer screw, by means of which its position was referred to 2796, would give 2582·5 for its true position; and I might easily have committed such an error in the excitement and haste of the moment.

At 1.40 a curious phenomenon was seen on the body of the sun at a point about 35″ distant from the limb (position-angle 266°). It was seen on both the C and F lines, but best on the former. The line was slightly bulged for about 8″ in length, and both above and below the bulge there was a little blaze of light extending some 5″ or 10″ each side of the dark line, *but without reversing it.* The appearance is just what is seen on bisecting a bright star with a wire not quite thick enough to cover it. Plate I., Fig. 11, (the lower portion) represents the phenomenon.

Oct. 8th.—1.50 to 4 P. M. Weather very fine for observation.

No.	Position.	Latitude.	Height.	Remarks.
1	70°	+ 48	135″	Enormous, Fig. 6, Plate I.
2	95	+ 23	25 to 35	Three summits, bright.
3	125	— 7	45	Faint flocculi, detached from limb.
4	170	— 52	30	Faint.
5	184	— 66	15	
6	237	— 61	30	
7	255	— 43	35	Very bright and curious. Figs. 7 and 8, Plate I.
8	290	— 8	15	Bright though small.
9	340	+ 42	25	Faint.

A day's interval had entirely altered the appearance of No. 1, as is at once evident on comparing Figs. 5 and 6, Plate I. (The lat-

ter was taken at 3.30 P.M.) No. 2 had become much more conspicuous than on the day preceding. No. 3 would very likely have escaped notice had not attention been naturally directed to the point where so magnificent phenomena were exhibited only twenty-four hours previously. Nothing remained but mere debris, a few faint filaments of nebulosity floating above the limb. No. 5 is undoubtedly identical with No. 6 of the 7th, and hardly altered. No 7 was an active little affair, which varied in form with great energy and rapidity, as will be evident on comparing Figs. 7 and 8, Plate I.; the first representing its appearance at 2.30 and the second at 4 P.M.

For about ten minutes (2.25 to 2.35) the C line in the spectrum of a brilliant floccule on the upper right hand extremity in Fig. 7, presented the appearance depicted in the upper part of Fig. 11, Plate I. For about 7″ the line was double and this when the slit was closed to the utmost, showing that the doubling originated not in a mere juxta-position of two masses of moving gas, but in their superposition, one in front of the other; one of them receding from us at the rate of some 60 miles per second.

Oct. 11th.—3.30 to 5 P. M. Clear but too windy for sketching.

No.	Position.	Latitude.	Height.	Remarks.
1	70° to 85°	+ 32° to 47°	180″	Enormous, diffuse, amorphous, in several masses, nowhere very bright.
2	102	+ 15	35	Faint.
3	125	— 8	....	Small faint cloud 2)″ above limb.
4	138	— 21	30	Pretty bright.
5	160	— 43	45	Bright.
6	170	— 53	30	Little horn, faint.
7	240	— 51	60	Cirrus and flocculent, fairly bright.
8	260	— 37	35	Bright.
9	315 to 330	+ 28 to 43	50	A long mass of cumulus form.
10	350	+ 63	35	Bright, a low flat arch, Fig. 18.

I suppose, though it hardly seems possible, considering that since the 7th the sun had rotated more than 45°, that No. 1 of this day must be identical with No. 1 of the 7th and and 8th. No spot appears at or near its base. No. 3 seems also to be the remainder of the great prominence of the 7th, but this is very doubtful.

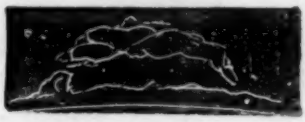


Fig. 18, No. 10, Oct. 11th.

Oct. 22d.—2 to 4 P. M. Rather windy.

No.	Position.	Latitude.	Height.	Remarks.
1	65°	+ 52°	45″	Faint.
2	120	— 3	25	Small and faint.
3	155	— 38	70	Bright. A nearly straight vertical pillar.
4	165	— 48	35	2 horizontal clouds, cirro stratus.
5	240	— 57	45	Faint.
6	280 to 290	— 12	15	Long and low.
7	335	+ 28	15	A little peak.
8	350	+ 53	20	Small but bright.

Nov. 4th.—3.30 to 5 P. M. Calm but very hazy.

No.	Position.	Latitude.	Height.	Remarks.
1	45°	+ 70°	35″	A little horn slightly curved.
2	52	+ 63	45	Sabre-formed, Cirrus and filmy.
3	93	+ 22	....	Small cloud at an elevation of 50″, 10″ by 30″.
4	115	0	25	Small and faint.
5	127	— 12	20	Very bright. Exactly over a small spot within 15″ of the limb.
6	152	— 37	70	Diffuse and structureless.
7	170 ± 5	— 55 ± 5	50	Faint.
8	252	— 43	45	Horn-shaped, rather faint.
9	260	— 35	20	A little horn rising from a hollow in the chromosphere, near large spot, Fig. 19.
10	310	+ 15	40	Faint and nebulous.
11	330	+ 35	55	Mushroom-shaped.
12	345	+ 50	65	Peculiar, Fig. 20.

Fig. 19, No. 9, Nov. 4th.

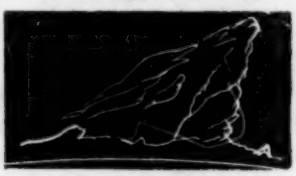


Fig. 20, No. 12, Nov. 4th.

From the observations above detailed it is evident that the spots and prominences obey nearly the same laws in respect to their dis-

tribution on the solar surface; but the prominences, which are far more numerous than the spots, approach nearer to the poles, and are more frequently found on the equator. I have never yet been able to watch a spot in its passage around the limb, so that I could observe its effect on the chromosphere, but my present impression is that certain depressions, from time to time observed in the chromosphere, (see Fig. 19,) are due to spots directly under them. In only one case (No. 5, Nov. 4th) have I found a prominence very near a spot, and then only a small one. The spot referred to in connection with No. 9, Nov. 4th, was about 25″ from the limb. Neither did spots make their appearance at or near the base of the great protuberances observed Oct. 7th. If they had they must have been seen on Oct. 11th. Whether the prominences are connected with the faculæ is a different question, and more likely, I think, to receive an affirmative answer. Their structure, as seen in my instrument, is almost invariably that of the most gauzy cirrus, composed of filaments and floccules so delicate that only an accomplished artist could hope to delineate them, and of which my figures hardly give an idea. Occasionally, however, they assume the apparent solidity of a cumulus or stratus. They are often surrounded by a hazy, structureless nebulosity without definite boundary.

They sometimes appear and disappear within a few hours, but it would seem that they also sometimes remain in nearly the same position for several days. Probably they are of the same order of permanency as the spots and faculæ.

The instrument employed in these observations was the same 5 prism spectroscope described in previous numbers of this *Journal.*

The forms of the prominences have been studied by opening the slit some 20″ or 25″. Only the smaller ones can thus be seen in their whole extent at once. The larger ones generally have to be worked out piecemeal, though occasionally one is bright enough to allow the entire opening of the slit. This was the case with No. 4 of Oct. 7th.

The dimensions are estimated, the basis of estimation being the known angular length of the slit 3′ 18″, determined by noting the time required for the sun's limb to pass across it. Some little irregularities upon the jaws of the slit, which give rise to lines running longitudinally through the spectrum, greatly aid the judgment, and the same is true of the intervals between the spectrum lines

near C, (through which all the observations have been made). I think the estimates reliable within 5″ as a general rule. The scale of the sketches is about $\frac{1}{100}$ of an inch to a second of arc, which represents very nearly their apparent size, referred to the limit of distinct vision, and corresponds to a magnifying power of 206. The position-angles are determined by a graduated screen on the piece which carries the collimator slit, and are correct within 2° or 3°, unless near 0° or 180°, or in windy weather, when the probable error might be from two to three times as great.

Hanover, N. H., Nov. 6th, 1869.

NOTE.—Having just received the volume of the *Comptes Rendus* of the French Academy of Sciences for the first half of the current year, I find that I have been anticipated by M. Faye, in respect to the method of observing the contact of an opaque body with the disc of the sun by means of the spectroscope.

At the Session of Monday, January 11th, 1869, he proposed essentially the same use of the instrument in a discussion upon the observation of the transit of Venus.

Hanover, Nov. 16th, 1869.

Explanation of Plate.

Figs. 1, 2, 3 and 4 represent the different forms assumed by a very brilliant protuberance observed Oct. 7th—position-angle 125°. The first was taken at 2.20 P. M., the second at 2.35, the third at 2.55, and the fourth at 3.30.

Figs. 5 and 6 are drawings of a large prominence observed Oct. 7th and 8th—position-angle 70° to 80°. Fig. 5 corresponds to 2.45 P. M. of the 7th; Fig. 6 to 3.30 P. M. of the 8th.

Figs 7 and 8 represent a small but active little prominence observed Oct. 8th—position angle 255°. Fig. 7 gives its appearance at 2.30; Fig. 8 at 4 P. M.

Fig. 9 represents a small but very bright goblet-shaped prominence observed Oct. 7th—position angle 355°; time 1.50 P. M.

Fig. 10 represents a small prominence observed Sept. 28th—position-angle 172°; time 5.10 P. M.

Fig. 11. The upper portion represents a doubling of the bright C line observed in the spectrum of the prominence delineated in Figs. 7 and 8. The precise point of the prominence which produced the doubling was the upper right hand corner in Fig. 7.

The lower portions of the same figure represents an appearance observed in the dark line C, on the body of the sun, Oct. 7th, 1.40 P. M., at a point 35″ from the sun's limb—position-angle 266°

Fig 1.

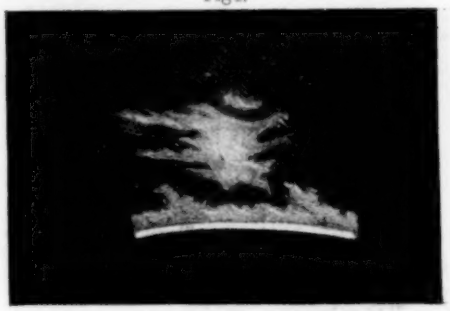


Fig 2.

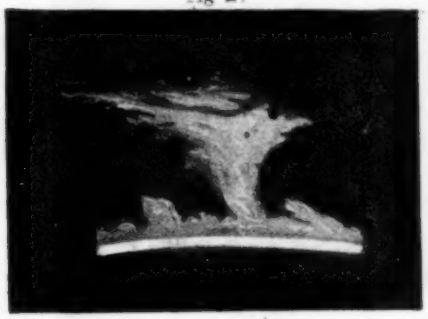


Fig 7.

Fig 8.

Fig 3.

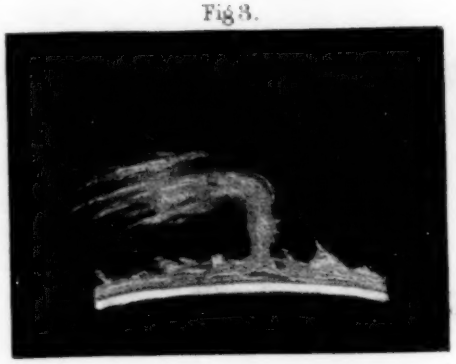


Fig 4.

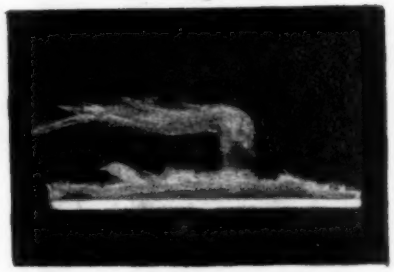


Fig 9.

Fig 10

Fig 5.

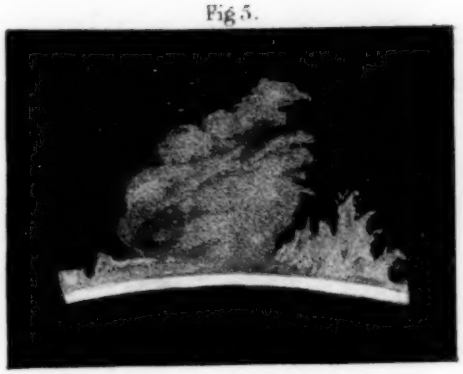


Fig 6.

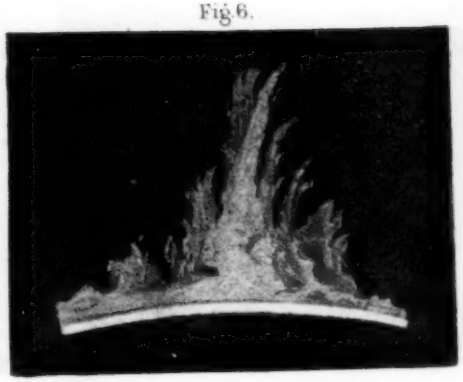
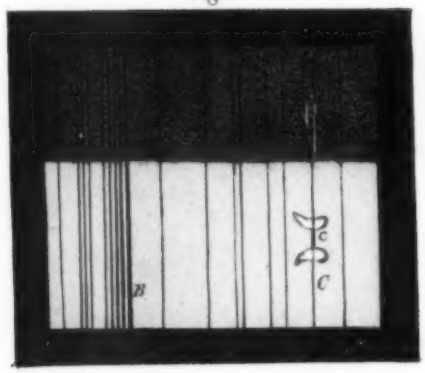


Fig 11.



THE FESTINIOG RAILWAY.

THE little Festiniog Railway, of 2 feet gauge, presents a striking example of commercial success, and did its yearly accounts come before the general public they might, perhaps, create a feeling of astonishment. The original capital of the company was 36,000*l.* applied to a line of 13 miles, but, their borrowing powers being exhausted, they have since almost reconstructed their line, erected workshops, manufactured their rolling stock, &c., wholly out of revenue, until the whole expenditure now stands at about 86,000*l.*, the company having this year obtained powers to capitalize the revenue thus applied.

In the year ending June 30th, 1868, the train mileage was 46,732 miles, averaging six trains each way daily for the 313 working days of the year, or, say, 1,878 down trains loaded with slates. The weight of slates taken into Portmadoc was 112,052 tons, equal to nearly 60 tons per train, while 14,693 tons of merchandise were carried on the return trips, besides passengers, both ways, paying 3,381*l.* The slate trucks, of course, return empty from Portmadoc to the quarries, the earnings from slate traffic being wholly derived from the down trains, although, by the usual railway fiction, the trains which really run all the way down hill, are, we believe, called "up trains." The carriage of slates returned 15,798*l.* 18s. 7d., equal to nearly 2s. 10d. per ton carried, for the 13 miles down, or 2d. per ton per mile, and 13s. 6¼d. per down train per mile. The total receipts were 22,852*l.* 13s. 5d., or 9s. 9¾d. per train mile in both directions. The working expenses were 9,700*l.*, or, say, 42 per cent. of the earnings; but of this sum 1,223*l.* were royalties paid under the name of "tonnages," 779*l.* were parish rates, 382*l.* passenger duty and income tax, 1,481*l.* for station masters and staff, &c.; the charge to locomotive department being 700*l.* only. The actual locomotive expenses are very moderate, notwithstanding that with driving-wheels but 2 feet in diameter, and with coal at 15s. per ton, the cost of fuel is necessarily rather high. Thus it will be seen that the net profits of this little railway have amounted to more than 30 per cent. of the original capital, and to upwards of 12½ per cent. on the total outlay on the undertaking, the larger portion of which has been paid out of revenue.

Franklin Institute.

Proceedings of the Stated Monthly Meeting, November 10th, 1869

The meeting was called to order with the Vice-President, Mr. Coleman Sellers, in the chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the Minutes of the Board of Managers and reported the donations received at the stated meeting held November 10th inst.:—From the Royal Astronomical Society, the Zoological Society, the Statistical Society, and Francis Cranmer Penrose, Esq., London; The Literary and Philosophical Society and the Association for Preventing the Explosion of Steam Boilers, Manchester, England; l'Academie des Science, l'Impereal Ecole des Mines, et la Société d' encouragement l'Industrie Nationale, Paris, France; the Natural History Society, Montreal, and the Literary and Historical Society, Quebec, Canada; Hon. Hamilton Fish, Secretary of State, Prof. J. H. C. Coffin, Superintendant of the American Ephemeris and Nautical Almanac, the Smithsonian Institution and Frederick Emmerick, Esq., Washington, D. C.

The Actuary further reported that Mr. James S. Whitney had resigned his membership in the Board of Managers.

The various Standing Committes reported their minutes. The Resident Secretary read his report on Novelties in Science and the Mechanic Arts, after which the meeting, on motion, adjourned.

HENRY MORTON, *Secretary.*

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